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Castings Aid Production of Pure Chemicals

SEVERE operating conditions which are encountered in the pharmaceutical and chemical industries, and the necessity for producing pure materials, have created a wide field for various types of cast iron equipment lined with enamel or glass. In such operations as the reduction of organic compounds by zinc and hydrochloric acid, evaporation of commercial muriatic acid to produce hydrochloric acid fumes, evaporation of hydrochloric acid solutions of platinum chloride, generation of hydrogen cyanide for fumigation purposes, manufacture of rubber accelerators for shortening the time of curing rubber, manufacture of organic arsenical compounds, storage of sulphurous acid bleach-liquors, and many others, glass or enamel lined cast iron equipment is used extensively. This equipment is available in the form of shallow dishes or pans, open top kettles, either jacketed or unjacketed, stills, vacuum pans, digestors and reaction kettles. One type of reaction kettle, designed for a variety of uses, is constructed with a cast iron jacket and a cast iron head, which is bolted to the jacket. An interchangeable inner liner is used. In addition, the kettles often are built with cast iron legs. A wide variety of reaction kettles are used, one manufacturer producing them in sizes ranging from 2 to 300 gallons capacity and in 44 standard models and numerous combinations.

Many Reaction Kettles Are Built With Cast Iron Exteriors

Find Where Castings May Be Sold.

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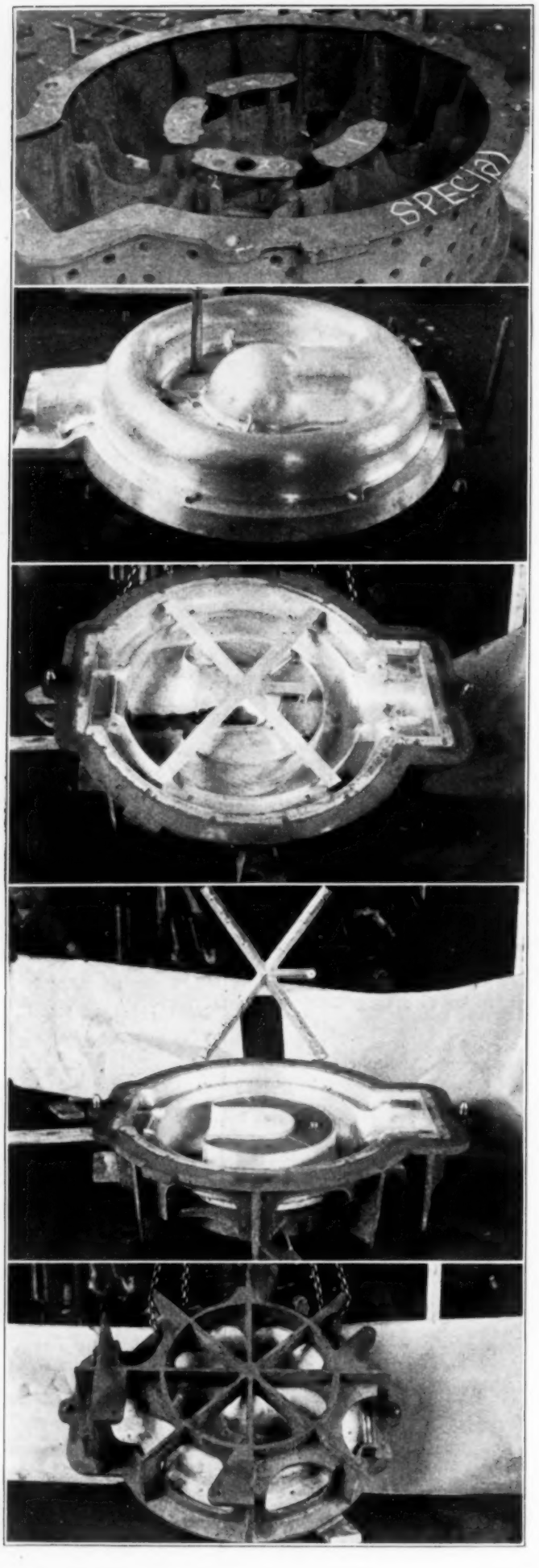


Design Patterns for M

Extreme Accuracy Combined with Strength To Jolt Machine Are Incorporated in Furnace Pat

GENERAL contract which was assumed by the Osborn Mfg. Co., Cleveland, to supply the new Peninsular Stove Co. foundry, Detroit, with all the molding and sand handling equipment required, included the production of a new set of flasks and patterns for the hot air furnace section of the shop. As explained elsewhere, all the equipment was synchronized for a definite steady production of castings from three independent units, one for fire pots and grates, one for feed chambers and radiators and one for miscellaneous small parts.

Many factors had to be considered in designing and constructing the flasks and patterns. The first requisite in the flasks was rigidity and the second was accuracy of dimension. These flasks had to maintain their shape and usefulness for a long period under severe operating conditions. Instead of being used just once a day as under the old regime, rammed carefully by hand, poured, shaken out and stacked in pairs until the following day, the flasks in the new installation are dropped from a crane on to a molding machine where they are filled with sand from an overhead bin and then flask and sand are subjected to a severe jolting action until the sand is packed firmly around the pattern. After the mold has been closed and poured it is placed on another jolting apparatus where the sand falls through a grating in the floor, where the casting is removed with a hook and from where the two parts of the flask are sent on a conveyor to their appointed places back of the two molding machines. The most extreme accuracy of dimension and guide points is required, because the same cope and drag together rarely go around the circuit twice in succession.

Flasks have to fit the patterns closely, partly to minimize the amount of sand required, but principally to do away with the use of gaggers, soldiers, nails or any other loose lifting devices. Sand strips inside the flange and stools fastened to certain bars as shown in Fig. 1 accomplish this purpose. Upper and lower flanges of most

Left—Figs. 1 and 2—Cope Flask and Pattern Respectively for Radiator Section. Figs. 3 and 4 Show the Special Type Gate and Manner of Application. Fig. 5—Cast Iron Cradle Is Planed Accurately on the Bottom and Machined on the Inside to Grip the Aluminum Pattern Tightly

for Machine Molding

To Resist Severe Service Requirements of a Patterns Recently Made for a Detroit Foundry

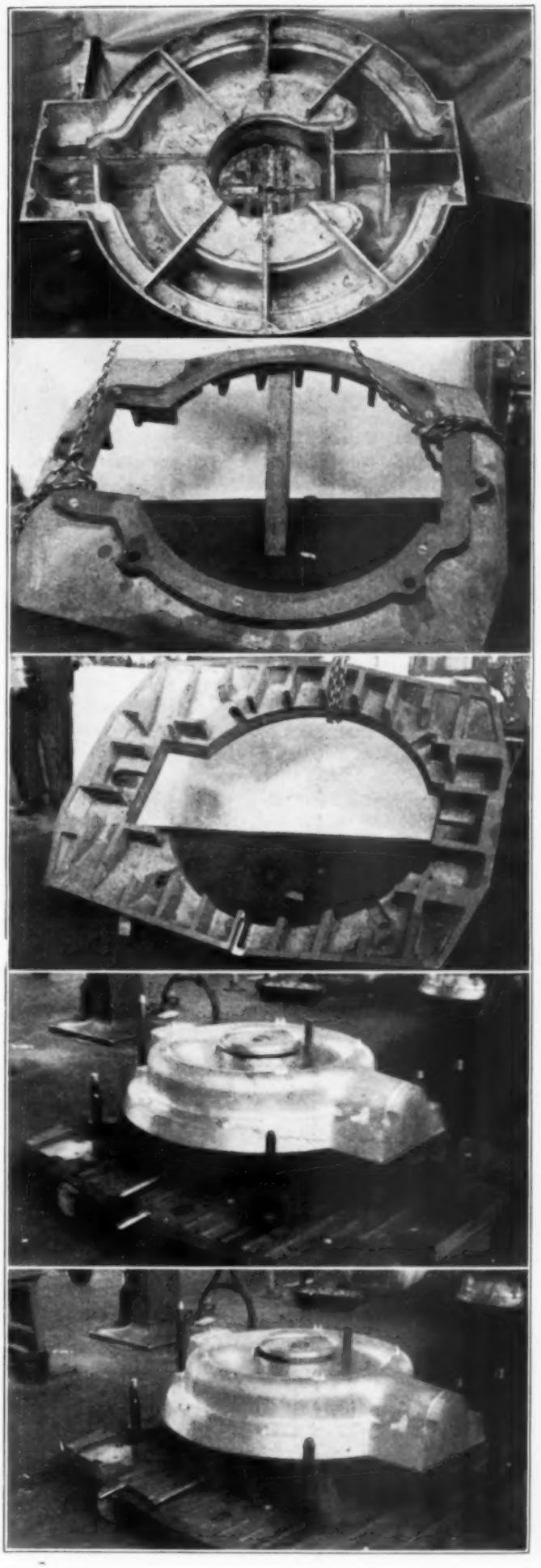
By Pat Dwyer

of the flasks are machined. In others, like the one illustrated, only the flange which comes into contact with the pattern plate and later with the second half of the mold, is treated in this manner. The pads in the center are machined and then fitted carefully so that they may rest firmly on the inside while the circular flange rests on the outside.

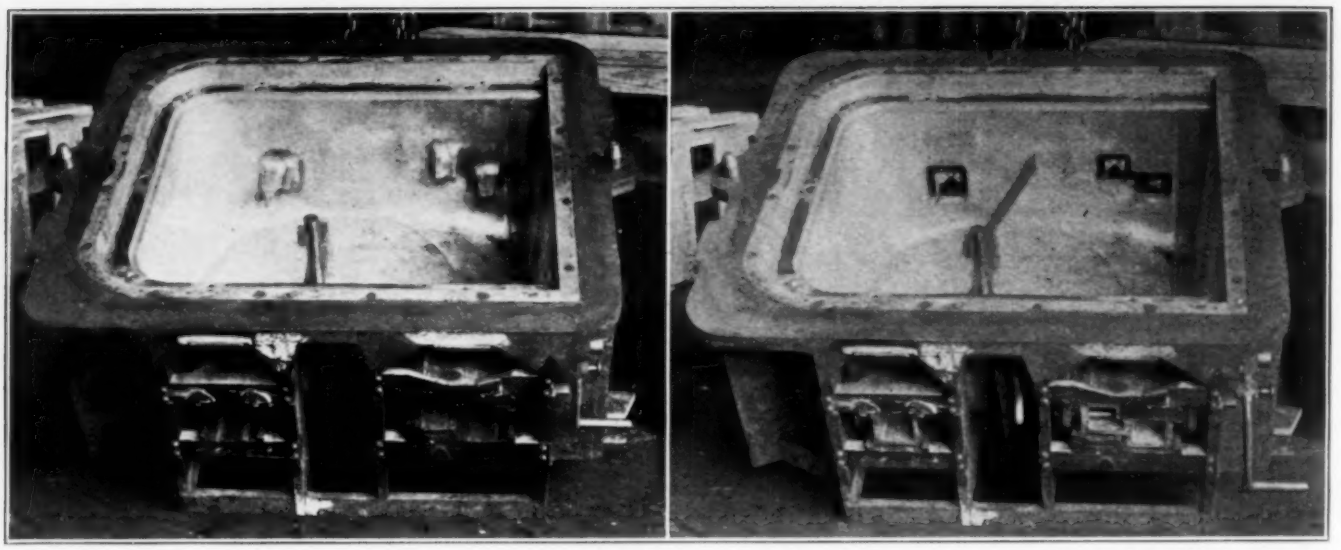
Bars in these flasks differ to some extent from those usually seen. Instead of presenting a uniform thickness from top to bottom with the lower edge chamfered to some extent on one or both sides, these bars are thickest at the top and gradually taper toward the bottom. In other words they are as so many wedges. It is claimed this form of bar construction facilitates the flow of sand in a flask mounted on a jolt machine. No tucking is required under the bars and in practice it has been found that the sand packs as uniformly under the sharp edges of the bars as elsewhere in the body of the mold.

Wood pattern for the flask section presented an exact replica on the inside, but the outside was surrounded with a core print 6 inches in width and the full height of the flask. Thus while the bars left their own impression in the green sand mold the outside was formed with a number of dry sand cores. Some of these cores were plain. Others contained recesses for the trunnions and guide lugs. Each core carried rows of tapered 1-inch projections designed to touch the green sand wall of the mold on the inside and thus form vent holes in the wall of the flask.

This particular flask shown in Fig. 1, was made of gray iron, a metal that was used extensively for flasks, pattern cradles and plates. On a few jobs where lightness was an important consideration, the flasks were made of cast steel. In addition to the usual vent holes in the bottom plates, other vent holes were placed in the ribs on the bottom, so that the steam and gas instead of accumulating in the pockets, might escape readily. This feature became one of major importance



Right—Fig. 6—Aluminum Patterns Are Strongly Braced. Figs. 7 and 8—Stripping Plates Carefully Machined and Fitted Show Rugged Construction. Figs. 9 and 10—A Small Flange Around the Center Ring Is Assembled in Four Sections and Is Manipulated Through a Shaft and Crank Handle



Figs. 11 *and* 12—*The Lugs on the Sides of the Patterns Shown Are Moved In and Out by a Somewhat Similar Device*

on the plates designed to serve as combined plate and drag.

This combined plate and drag presents an interesting departure from the equipment usually employed for making these castings. According to the older or former method, the pattern is placed in a follow board with the edge of the pattern flush with the face of the board. The drag is placed on the board. Pattern and drag are filled with sand rammed to the proper density. A bottom board then is rubbed down, after which the entire assembly is rolled over. The follow board is removed and the cope is rammed directly over the pattern as it sits on the drag.

In the newer method practiced at the foundry of the Peninsular Stove Co., two patterns are provided, one for the cope and one for the drag. In this instance the term drag is slightly misleading since no drag flask is required. The pattern is mounted in such a manner that the upper edge as it lies in the cradle may be covered with 2 inches of sand. Thus when the pattern and extension are filled to the top with rammed sand the upper surface is scraped off flush and a bottom plate is rubbed down into place. The entire assemblage is rolled over and the pattern is removed, leaving the mound of sand constituting the inside part of the mold sitting on the plate. The plate of course is provided with pins which locate it accurately, first on the pattern cradle and later under the cope.

Detail of pattern construction varies but slightly between the pattern employed for making the copes and that employed for making the drags. The outside and inside of the cope pattern are shown respectively in Figs. 2 and 6. In these illustrations it will be noted that the aluminum pattern is ribbed heavily on the inside and then is attached to a carefully machined and heavily ribbed cast iron plate by a number of ½-inch stud bolts on the rim and by others on the ribs. The iron plate is provided with suitable lugs by which it may be attached firmly to the jolt table of the molding machine.

This part of the mold is not rolled over. The pattern remains on the machine and the cope is lifted straight upon the stripping plate shown in Figs. 7 and 8. The lifting plate is made in two parts firmly bolted together. The lower part strongly ribbed and with an opening to accommodate the largest size radiator pattern. The upper part is an irregular

Concludes Series

SOME of the interesting features in the design and construction of metal patterns for hot-air furnace castings are covered in the present article, the third in a series dealing with a foundry recently erected and placed in operation on the outskirts of Detroit by the Peninsular Stove Co., one of the oldest engaged in that line in the city. The first article published in THE FOUNDRY, *April* 15 *dealt with the general layout and the sand handling methods and equipment. Molding detail, cupola practice and method and equipment for handling the iron before and after it is melted were described in the issue of May* 1.

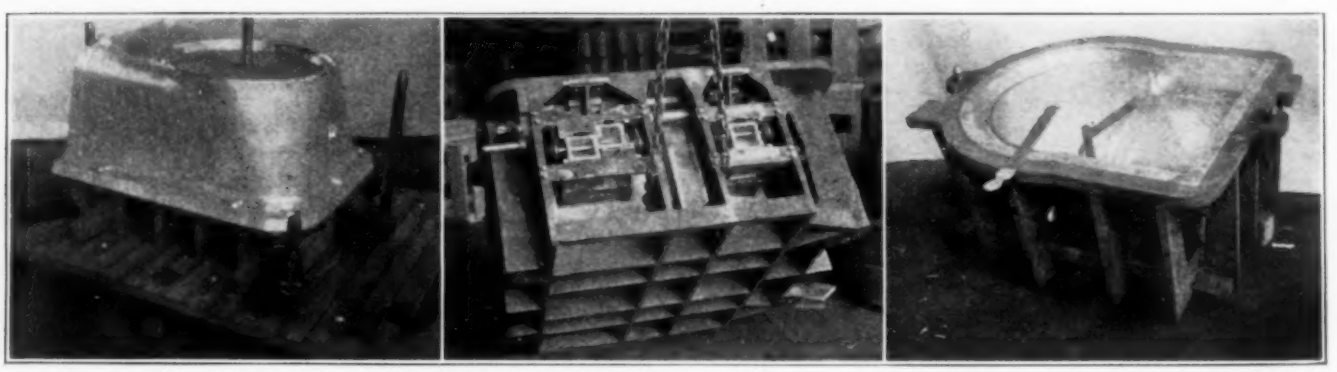


Fig. 13—*Aluminum Cope Pattern Mounted on Cast Iron Frame. Fig.* 14.—*Side and Bottom View of One of the Cast Iron Cradles with Mechanism for Stripping Lugs Through the Sides. Fig.* 15—*Cradle for the Pattern Shown in Fig.* 17

Fig. 16—Horizontal Gates Are Pulled Out Through the Side of the Pattern Before the Pattern Is Removed from the Sand Mound. Figs. 17 and 18—Cope Pattern Mounted on a Cast Iron Base Is Provided with Long Guide Pins and Four Anchor Bolts for Holding the Flask in Place

shaped ring about 1 inch thick and with the inner edge carefully finished by hand to fit closely against the radiator pattern shown in Fig. 2. This ring is detachable and may be replaced with others of varying sizes to fit other patterns in the same line. The same general ideas are embodied in the pattern and stripping plate equipment for the fire pot shown in Figs. 25 and 26.

Secure Rigidity

Pattern and cradle for making the drag part of the mold are shown in Figs. 3, 4 and 5. The pattern proper is made of aluminum and the cradle is made of gray iron to insure greater strength and rigidity. The principal reason for making the pattern in two parts is to facilitate its construction. Manifestly the comparatively light aluminum inside part of the pattern can be handled, adjusted and finished much more readily than the entire assemblage. Also the practical patternmaker will note at a glance that the construction of the pattern is simplified to a considerable degree and the same advantage is found in molding the castings. A third advantage lies in the fact that the one cradle may be used with several aluminum patterns for the radiator section.

In the beginning an attempt was made to use the same wood pattern twice in molding the aluminum pattern for the inside and the outside, that is for the cope and drag molding machines. The ribs shown on the inside in Fig. 6 were removed and a corresponding set was attached to the outside. Also the necessary adjustment was made in the rim flange to insure a *touch* between the joint surfaces of the cope and drag parts of the mold made from these patterns.

Experience showed that the plan presented no advantage and that better progress was made where two wood patterns were constructed, one for the cope aluminum pattern and one for the drag. The castings from the two patterns matched each other as closely as the pair made from the one pattern in which the ribs and flange had been transposed. In fact the second pattern held its shape better when constructed as an individual unit, than it did when it appeared as a tinkered edition of the first pattern.

All the patterns were made by the Motor Patterns Co., Cleveland. This work included design and construction of the wood patterns for aluminum pattern castings and for iron castings for cradles, stripping plates and flasks. The castings were made outside and then taken to the shop of the Motor Patterns Co., where they were machined and fitted and where sample castings were made before the equipment was crated, shipped and delivered to the plant of the Peninsular Stove Co., in Detroit.

To avoid any possible confusion perhaps the statement should be made that the particular radiator casting under discussion is cast in two parts which afterward are bolted together to form a heat radiation chamber. The pattern for the section which occupies the upper position in the furnace is shown in Fig. 2. Also in Figs. 3, 4 and 5. A dome shaped chamber in the center is connected to the outside circular chamber. The pattern for the lower section is shown in Figs. 6, 9 and 10. The chamber in this section contains an opening in the center surrounded by a narrow projecting flange by which the radiator is attached to the combustion chamber of the furnace. The flange on the pattern is divided into four sections. These sections in turn are connected to an ingenious sliding cam mechanism on the inside controlled by a single lever terminating in a crank handle projecting beyond the lower edge of the stripping plate. With the crank handle thrown to the right the flange segments occupy their proper position around the opening in the pattern. When the crank is thrown to the left the segments are drawn in so that the mold may be lifted away from the pattern. This feature is shown in Figs. 9 and 10.

Uniform Castings

The same general idea is illustrated in Figs. 11, 12, 13 and 14 which shows the pattern and the equipment for handling the lugs on the side of the ash pit pattern. In this latter in-

Figs. 19 and 20 Show the General Style of Construction Followed in the Bottom Plates Which Also Serve as Drags. Fig. 21—This Is the Cheek for One of the Fire Pot Sections

stance two levers are provided, one for each side. Lugs and other loose pieces mounted in this manner present the advantage of absolute accuracy in location. They cannot go astray or become shifted, irrespective of how the sand is rammed around them.

As a result of the precision attained in equipment and the uniformity attained by ramming the sand mechanically it is claimed that the castings are identical to a degree never found where the molds are made by hand from individual patterns. In the older establishments where minor variations are found in the castings, each furnace must be assembled as a unit in which minor adjustments have to be made in the position of bolt holts, etc. The furnace then is taken apart with corresponding parts marked so that they may be reassembled at their destination. All this extra handling increases the ultimate cost.

Special Gates

Under the new method in which mechanical equipment has been used almost exclusively, the castings are so uniform that the manufacturer finds it necessary to assemble approximately only one out of every fifty furnaces to test the accuracy of the fitting points. The remainder of the castings are shipped as cleaned in full assurance that they are interchangeable and will fit into place with the other sections at any point of assembly.

Method of gating the radiator casting has been changed to bring this feature into line with the general policy of simplification and retrenchment. Formerly these castings were poured four or five-up. That is four or five runners were provided around the outer rim and four or five men poured iron simultaneously into these runners from hand ladles. Iron required to fill the gates and runners amounted to a considerable total. The employment of four men as pourers was not practicable under a system where the molds move on a conveyor.

An ingenious type runner developed specifically for this installation is

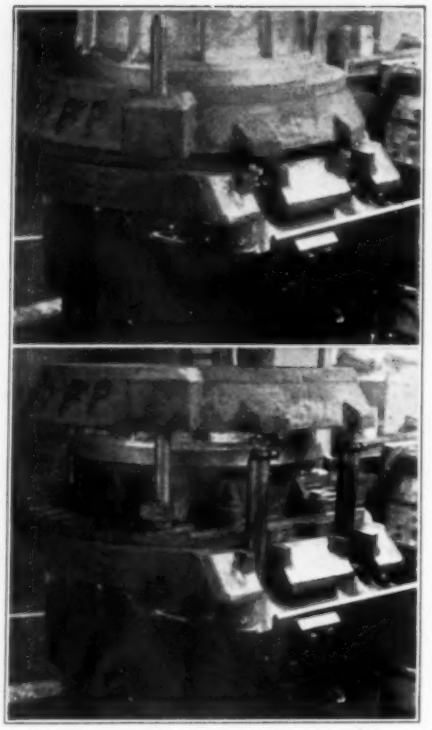


Fig. 25—Pattern for Forming Outside of Firepot Mold with Stripping Plate Down. Fig. 26—Same Pattern with Stripping Plate Raised

shown in Figs. 3 and 4. The sprue, or upright member of the runner is shown in Fig. 2. The basic idea of this gate is simplicity. The iron is poured from a bull ladle into one runner, instead of the four formerly employed. The four gate channels connected in the center to form a large *X* are designed to distribute the metal as rapidly at the bottom as it formerly was distributed from four points at the top.

The X-gate, triangular in cross section is provided with three small projections on the under side of each of the four branches as may be noted in Fig. 4. These projections approximately 3/16 x 1 inch rest on three points on the three edges of the radiator pattern. A short branch connects the *X* to a short vertical stump which rests on the parting surface of the drag pattern Fig. 3 and which corresponds in position to the upright runner shown on the cope pattern Fig. 2.

With the *X*-runner in position the drag pattern Fig. 3 is filled with sand and jolted. The superfluous sand then is scraped off flush with the raised edge of the pattern, which incidentally also coincides with the face of the cast iron cradle and the flat faces of the four branches making up the *X*-gate. In the illustration the gate is deceiving, since in reality it is more core print than gate. The *X*-pattern is removed from the sand and four *V*-cores are dropped into the cavities. The cores are designed to fill the cavities only part way. The remainder of the space is the opening through which the iron flows into the casting. The cores are slightly larger than the core prints and as a result they fit tightly when forced down into place before the bottom plate is attached to the cast iron cradle supporting the pattern. The close fit prevents any iron from leaking past the core on to the plate during the pouring operation which takes place later.

At the time of writing this style of gate still is in the experimental stage. Many of the castings are poured through a number of pencil gates on top connected to a circular basin. One of the principal objections to this type of runner is that the stumps must be chipped and ground on the exposed surface of the casting. The *X*-gate on the bottom of the casting breaks off clean and no finishing is necessary. Also a substantial saving of iron is effected with this style runner as compared with the pencil gates and basin in the cope.

Use Knife Gates

A still simpler type of gate is used on the ash pan casting. Various details of application may be noted in Figs. 11, 12, 13, 14, 15 and 16. The casting is poured in the position shown in Fig. 13. The drag pattern is shown in Fig. 15 with the gates and runner

(*Concluded on Page* 474)

Fig. 22—One of the Light Cast Steel Copes for the Fire Pot. Fig. 23—Showing the Application of the Inside Gate. Fig. 24—Strength and Long Service Are Built Into This Cast Iron Base for the Fire Pot Cope Pattern

WHICH Should Apply? —THEORY OR PRACTICE

By John Shaw

Part I

CERTAIN inspired references to the ignorance and want of initiative in research on the part of the practical iron founder has led us to put up to you for plain discussion, points that have some bearing on the question. To quote from one of the mildest of these critics, we are told that "much border line work could be captured from steel by the commoner material if the iron founder would follow the example set by the progressive steel founder," that to succeed led inevitably to the laborious synthetic method, etc. Now is this indictment a true one, and, if so, why?

In the first place a mild steel casting is a simple metallurgical problem (we are not referring to molding and other difficulties) and consists of only two elements that matter, iron and carbon, the others being either *cleansers* or in the case of sulphur and phosphorus kept as low as possible.

Under these conditions one can understand the utility of the binary or ternary diagrams, especially in view of the after heat treatment. Complex cast iron, on the other hand, is influenced by all six elements, each having considerable bearing on the final product. The history of steel also reveals the fact that it was not possible to make sound steel until the accidental discovery of the deoxidizing effect of manganese. Unfortunately, in some respects, fairly good cast iron can be obtained by simply mixing pig and scrap in any corner cupola, hence the lack of apparent need for research, combined with the fact that the price paid has left no margin.

A glance at the analyses of a typical mild steel casting and a cylinder iron as shown in Table I shows that their only similarity consists in that both contain the same elements, but in totally different proportions.

In view of the above analyses, has not the attempt to apply the theories evolved in the case of steel to cast iron been a hindrance to progress rather than a help? The statement that cast iron is simply a steel interspersed with graphite may be useful to the teaching profession, but there is no doubt it has not helped to a better understanding of complex cast iron. In short, is the synthetic method of approach that was successful in steel, the best for cast iron?

Many research workers have tackled cast iron by choosing some particularly pure white iron, with the result that much literature exists concerning metal of such qualities and compositions as are met with in no foundry in the world.

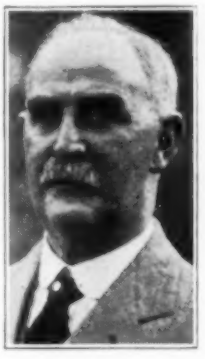
To take only one instance, it is nearly 20 years since Gonterman published his work on the effect of silicon. Last year we had a most carefully prepared paper by Dr. Hanson on the same subject, putting forward a new theory that might reconcile the divergent views on the primary graphitizing point. At the same time, valuable as this contribution was, especially on the scientific side, it has added little to our knowledge of the ultimate structure that was not known previously. As the author states, the other elements in cast iron may alter the results, and also in cooling, equilibrium may seldom be reached. All the recent advance in cast iron has been founded on a cast iron base, having all the elements present in such quantities as are found in cupola work of which the work by Lanz, Emmel, and Donaldson are examples.

If the elements are taken in rotation as found in the two previous analyses, the total carbon of the steel casting is found to be limited to 0.2 per cent to 0.4 per cent. Up to this limit, according to Charpy, no graphite is formed at any temperature in the presence of even 2 per cent silicon. In cast iron carbon may be anything from 2.5 per cent to 3.5 per cent, and every element, melting temperature and mold temperature has an

Is British Expert

THIS article, the first of a series of three, is abstracted from a paper presented at the Philadelphia convention of the American Foundrymen's association.

John Shaw, author of the paper, has been associated prominently with the British foundry industry all his life, and for his contributions to the industry was awarded the John A. Penton gold medal of the American Foundrymen's association at the 1926 Detroit International Foundry congress where he also presented the British exchange paper. Mr. Shaw was educated at the Farnsworth grammar school, Widnes Technical school and Liverpool university. After completing his education he served his time as apprentice with the Widnes Foundry Co., and was made assistant foreman at the age of 19 years. He was in full charge of the foundry at 22 years of age. After six years in charge of a small foundry in Wales, he became foundry manager for Cochrane & Co., Dudley. For the past several years he had been manager of the Newhall works, Brightside Foundry & Engineering Co. Ltd., Sheffield, retiring in 1927. He joined the Institute of British Foundrymen in 1906 and for three years was president of the Birmingham branch. He now is president of the Sheffield branch.



John Shaw

Table I

Comparative Analyses of Steel and Iron

	Per Cent Total Carbon	Per Cent Silicon	Per Cent Manganese	Per Cent Sulphur	Per Cent Phos.
Steel Specification	0.2 to 0.4	0.26	0.6	0.04	0.04
Cylinder Iron	3.0	1.2	0.8	0.12	0.3 to 0.8

Table II

Data from Various Investigators

	Hatfield	Hamasumi 1st Series	Hamasumi 2nd Series	Hague	Coe		
Per Cent Total Carbon	3.07 to 2.95	3.35 to 3.33	2.90 to 2.93	2.47 to 2.95	2.88	3.04	3.22
Per Cent Combined Carbon	0.6 to 2.3	0.66 to 0.90	0.63 to 1.13	0.97 to 2.82	1.08	1.27	3.19
Per Cent Silicon	1.72 to 1.68	2.90 to 1.18	2.90 to 0.64	1.95 to 0.66	2.03	0.80	0.4
Tensile Strength. Tons (2240 lbs.)	12.7 to 11.41	7.44 to 10.07	16.5 to 18.4	.....	13.72	10.06	14.33
Size of Bar	1" x $\frac{3}{8}$"	$1\frac{1}{4}$" round	.....	1" square	1 inch square		

Table III

Analyses from Maurer's Work

T. C. %	C. C. %	G. C. %	Si %	Mn %	Phos. %	Sulphur %	Total Carbon and Silicon %	Brinell
2.7	0.91	1.79	1.36	0.77	0.50	0.09	4.06	161
3.81	0.87	2.94	1.44	1.23	0.06	0.06	5.25	105

effect on the final product. Even if the composition gives a pearlite structure, the tensile strength may vary from 9 tons to 17 tons (20,160 to 38,080 pounds), due entirely to the form and quantity of the graphite and the variation in the type of pearlite.

Effects of Silicon

Silicon in mild steel castings is about 0.2 per cent. Its function is to act as a cleanser and give rather better running qualities. In cast iron silicon is one of the dominating elements, and its influence on the condition of the carbon has much to do with the physical properties of the resultant casting.

It is 40 years since Professor Turner's famous investigation on the effect of silicon on cast iron was completed. Turner states that the interest taken in cast iron at that time and during the next few years was truly remarkable and was not confined to any single country. Without in any way diminishing the value of this discovery, there is no doubt that the abuse of the use of silicon has done not a little to lower the physical properties of cast iron.

A quotation from Keep's paper before the Philadelphia foundrymen will show what I mean: "Silicon is the only thing necessary to the foundry, all other things in cast iron can be overlooked. If the shrinkage is not low enough—if the iron is too hard or not gray enough, add silicon; it remedies all other defects. It is the only variable to consider, and it is the easiest to manage." While this quotation is extreme, there is no doubt that in the craze for fast machining on one hand, and the softening of cheap materials, irrespective of their composition, silicon additions still are used to the detriment of the physical properties.

With the advent of the Institute of British Foundrymen, fresh interest was created in the various problems.

The personal interest of Professor Turner in this movement led to the remarkable series of investigations undertaken at Birmingham university. Those of Levi, Coe and Hague are quoted today. Hatfield, who at that time was interested in malleable, also did some good work. Hague presented a paper before the Iron and Steel institute (London) on the influence of silicon on pure cast iron on October, 1910, while Coe, following other papers, dealt with the physical properties in 1913. Broadly speaking, the results agree, that is, with the separation of graphite, due to the effect of silicon, the strength and hardness of the bars decrease.

One of the points that seems to have been overlooked was the effect of comparatively wide variations in carbon. The chief object in using a synthetic mixture was to be sure that there should only be one variable, yet in all these experiments the carbon varied between 2.26 per cent and 2.95 per cent, a difference of 0.69 per cent. This would make a considerable difference on the final structure and strength of the unannealed bars.

An examination of any published chart of blackheart malleable giving depth of chill in relation to carbon and silicon content, shows that with silicon below 0.7 per cent, two parts of carbon will have the same effect as one part of silicon on the depth of chill. With the silicon from 0.7 per cent to 1.2 per cent, four parts of carbon are equal in effect to three points of silicon. As the chill disappears at the higher silicon this is as far as our definite knowledge goes; we also know quite definitely that the addition of 0.06 per cent silicon to an analysis just mentioned will decrease the depth of the chill $\frac{1}{4}$-inch,

Table IV

Results of Various Workers Using Low Sulphur

	Total Carbon	Combined Carbon	Silicon	Manganese	Sulphur	Phos.	Pounds Transverse Strength Bar 12"x1"x1"	Deflection Inches	Tensile Strength Tons (2240 lbs.) per Square Inch
Coe	3.28	1.13	1.0	0.014	Trace	0.09	2732	0.094	12.67
Coe	3.15	0.82	1.02	0.846	Trace	0.09	3461	0.092	16.59
Coe	3.02	0.92	1.62	0.04	0.015	0.093	2665	0.132	10.10
Coe	3.04	0.43	1.50	1.03	0.015	0.093	3035	0.11	15.11
Coe	2.79	1.06	2.24	0.016	0.016	0.027	2240	0.08	9.92
Coe	3.03	0.69	2.42	1.96	0.016	0.027	3203	0.12	15.47
Hague and Turner	2.77	0.84	3.06	Trace	Trace	Trace	.....	.....	.....
Hague and Turner	2.62	0.22	3.00	0.50	Trace	Trace	.....	.....	.....
Hamasumi	2.90	0.82	1.65	0.15	0.02	0.01	.....	.....	16.8
Hamasumi	2.89	0.76	1.72	0.30	0.02	0.01	.....	.....	18.7
Hamasumi	2.96	0.86	1.61	0.69	0.02	0.01	.....	.....	19.9
Hamasumi	3.04	1.07	1.71	1.34	0.02	0.01	.....	.....	22.3
Hamasumi	2.84	0.77	1.85	3.94	0.02	0.01	.....	.....	26.3

so the effect of carbon on the structure can be calculated roughly.

Since the war the formation of the British Cast Iron Research association has led to fresh interest in cast iron problems, of which the paper mentioned by Dr. Hanson is one result.

We have purposely not gone into details concerning the various investigations, because of the ground we wish to cover, but anyone interested will find the whole question dealt with, either in Turner's, Hatfield's, or Hurst's books. Table II gives roughly the results of the various workers. The size of the bars and method of casting varied so that the results are not helpful, although the influence of silicon is shown.

Data of Table II raises the whole question of the suitability of using small bars to obtain results on which are based such diagrams as Maurer's. A 1-inch square or 1¼-inch diameter bar presents so much superficial surface in relation to its cubical content that the quick cooling rate masks large variation in composition. The data of Table III taken from the figures in the latest Maurer diagram are samples, yet these showed all pearlitic structures.

Manganese Improves Fluidity

This element in mild steel castings is useful as a deoxidizer, to neutralize the effect of sulphur, and also to increase the yield point and ductility.

In gray iron, investigations have been made by Stead, Coe, Wust and others. The position at present is summed up best by Hamasumi; first, that manganese up to 2 per cent in the presence of silicon as in gray iron, does not retain carbon in the combined form and second, that with the increase of manganese the pearlitic structure is altered considerably and tends to be sorbitic. Hence the increased brinell hardness with no increase of combined carbon; with more than 0.5 per cent the tendency is for the graphite to be in a *whirl* form. Manganese also improves fluidity and tends to make a good, sound casting.

Table VI

Data on Good and Bad Cylinders

	Total Carbon	Combined Carbon	Silicon	Manganese	Sulphur	Phos.
A	3.34	1.44	0.90	0.25	0.136	0.39
B	2.98	0.65	0.71	0.49	0.120	0.31

Table VII

Data Taken from Roll Tests

T. C.	C. C.	Si	Mn	Sulphur	Phos.	Depth of Chill on Test Piece	Depth of Chill on Roll	Loss	Sulphur Ratio
2.96	0.55	0.50	0.42	0.089	0.45	2⅛″	¾″	1⅜″	4 to 1
3.16	1.37	0.83	0.27	0.164	0.50	1⅞″	⅞″	½″	1.5 to 1

There is so large an amount of evidence on the first point that one wonders at the often repeated statement, that manganese after satisfying any sulphur present, hardens cast iron in the proportions usually found. Outerbridge stated that this is a mistaken notion and gives proof. A glance at Coe's or Hamasumi's tables also confirm. Dr. Howe, discussing Hatfield's paper, states "The influence of manganese in increasing the stability of the carbide is opposed by some additional fact, as has so often been noticed. For instance, Mr. Hatfield's *S*33 and *S*23 are closely comparable except manganese, and so are *S*34 and *S*24. After heating to 950 degrees Cent., the higher manganese specimen in both cases graphitize more than the lower manganese one."

Wust and Miny in their paper on sulphur in cast iron say "Sulphur counteracts the graphitizing effect of manganese."

Coe in a later paper on the influence of metalloids on properties of cast iron, replying to the discussion states "The experiment performed by Hague on the influence of 0.5 per cent manganese has been repeated under the same conditions, and also under different conditions, always with the same results; so that it may be definitely stated that in siliceous cast irons with the ordinary rate of cooling, the addition of the first 0.5 per cent manganese results in a softening, owing to the precipitation of secondary graphite."

Allison, in a paper on chilled rolls, states "Ferromanganese was added in the ladle in several instances, but it was found that thereby the amount of chill is seriously affected. What appears to be a critical point is a percentage of 0.36 per cent manganese and it was found undesirable to have the manganese content any higher."

Table IV gives the results of the various workers, with a minimum of sulphur present.

Whether this graphitizing action of manganese is a direct one or whether it is simply due to the considerable lowering of the pearlite point we leave to abler metallurgists. The latter combined with the shorter freezing range would account for the finer graphite usually found and also for the higher brinell number without affecting the machining speed. The latter theory would also offer an explanation for the necessary time element noticed with the graphitizing effect of manganese. For instance, Cook found if he raised his manganese above 0.4 per cent he was liable to machining trouble in the bore of his cylinders. As his main body core was chilled lined, the cooling rate would be too quick to allow the secondary action of the manganese. Our experience with certain rolls,

Table V

Sulphur Does Not Affect Running of Metal

	Total Carbon	Combined Carbon	Silicon	Manganese	Sulphur	Phos.	Trans. Strength Pounds on Bar 12″x1″x1″	Deflection in Inches	Tensile Strength (2240 lbs.) Tons per Square Inch	Shore Hardness No.
Coe	2.79	1.06	2.24	0.016	0.016	0.027	2240	0.080	9.92	45
Coe	2.90	1.06	2.24	0.016	0.104	0.027	3125	0.114	13.04	45
Coe	2.70	1.13	2.37	0.016	0.180	0.027	3994	0.150	21.2	43
Hamasumi	2.90	0.79	1.77	0.02	0.049	0.01	.....	.....	21.4	*210
Hamasumi	2.84	0.74	1.76	0.02	0.087	0.01	.....	.....	23.0	*223
Hamasumi	2.85	0.81	1.82	0.02	0.120	0.01	.....	.....	22.9	*226
Hamasumi	2.80	1.04	1.87	0.02	0.176	0.01	.....	.....	21.5	*241

*Brinell hardness number.

points the same way as shown in Table VII. This we attributed to the excess ratio of manganese to sulphur.

The chill test in the first shows 2⅛ inches, while the roll only shows ¾-inch, a loss between the chill test and the roll of 1⅜ inches. The second roll only showed a variation of ½-inch.

Loudenbeck in a paper before the American Foundrymen's association gave a number of instances: "In the manufacture of large hydraulic cylinders it is necessary to have a close mottled structure to withstand breakage and prevent leakage. If the manganese is too high this mottled structure is replaced by a coarse graphitic structure. This is illustrated by two analyses. The bodies were 6 inches thick, *A* (Table VI) was a close mottled structure that gave very satisfactory results in all the 20 cylinders required; *B* analyses gave a fracture open and not mottled and the cylinder was not satisfactory. Manganese was too high in the defective cylinder which accounts for the low combined carbon and soft character of the mixture. Without doubt this cylinder would have been satisfactory if the manganese had been lower."

Critical Points

From the report in *Genie Civil* on ingot molds, it would appear there are two critical percentages of manganese to stand up to heat treatment. The usual specification was to limit ingot molds to 0.6 per cent. M. Groselaude found he obtained a rise in the number of casts made, up to this figure of 0.6 per cent with a maximum of 110 casts, then there was a sudden drop to below 20 casts with manganese at 0.8 per cent. This low figure continued until about 1.6 per cent manganese was present with an average of 140 casts. With manganese 1.75 to 2.25 per cent the average over two years was 175 casts. With further increases, the number of casts dropped rapidly.

Smalley's results on "Heat and Scale Resisting Cast Irons" might be quoted, although as these were white irons, they are rather outside the subject. His conclusions were that manganese:

1. Reduces the resistance to scaling.
2. Increases graphitization.
3. Decreases strength and should not exceed 0.30 per cent.

We have put these examples forward because of the excellent results obtained by Carpenter, Matsuura and Donaldson with high manganese irons showing special resistance to growth and giving good physical properties up to temperatures of 500 degrees C.

As all these results were obtained on small bars, it might be advisable to try out the behavior on thicker sections as diesel liners.

Before touching the manganese sulphide question, it would be well to consider the effect of sulphur. That sulphur is injurious to steel as iron sulphide is accepted at once, the great variation in the freezing point leading to the well-known structure, but in cast iron even with manganese as low as 0.2 per cent and sulphur as high as 0.2 per cent (which is as low and high as ever found in ordinary cast iron) no clear proof has ever been submitted showing the evil effect of iron sulphide as such. Coe states "The transverse strength, tenacity and hardness are increased by the addition of sulphur." Wust and Miny state "The tensile and transverse strengths and resistance to impact of low manganese irons are not impaired by sulphur; "In all cases the hardness is increased by the addition of sulphur independently of whether it is present as iron sulphide or manganese sulphide." Rhead, Cook and Hamasumi also agree. Rowe states, "Experience has shown that it is extremely difficult to get iron of high strength with abnormally low sulphur." Neither Cook, Coe or Hamasumi, found any difficulty with fluidity if cast at a high temperature. The latter named found the tensile was 1.3 to 2.5 tons (2512 to 5600 pounds) higher when cast at 1400 degrees Cent., instead of 1350 degrees Cent. Neither has the author experienced any difficulty in running metal with sulphur, 0.25 per cent; manganese, 0.35 per cent; not so much as with carbon down to 2.5 per cent. Table V gives some of the results.

Does Not Weaken

In view of the above facts it is difficult to account for the oft-made statement concerning the cause of the weakening effect of iron sulphide as such, in the amount found in gray iron. Is this not another effect of steel theories? Personally we have never seen iron sulphide in any iron with 0.2 per cent sulphur and 0.2 per cent manganese, neither have we ever met anyone who could produce a photo or sample showing iron sulphide with sulphur below 0.2 per cent; certainly not as a band surrounding the crystalline structure as may be found in steel.

Bolton in a paper before the American Foundrymen's association states, "In the author's experience he has never been able to find any evidence of sulphur network, and the idea that fracture depends on sulphur network is a myth."

From what has been said we may conclude that sulphur in cast iron is only harmful when it is present in such amount as to give an excessive quantity of free cementite or when other elements such as silicon have to be increased to neutralize this affect and reduce combined carbon to a reasonable figure; otherwise sulphur under control, is of great value as a strengthener and grain refiner.

If from any cause such as heavy steel additions, such as are used in cast irons developed by Emmel and Meehan, you nearly are forced to have a high sulphur, there are two ways to reduce your combined carbon. First, to increase your silicon or both carbon and silicon, in which case you gain little strength, owing to your coarser primary graphite and pearlite, also your resistance to growth at moderate temperatures is decreased. Or, increase your manganese thereby rendering part of your sulphur passive as manganese sulphide, while the excess manganese acts as a degasifier, grain refiner, and gives life as shown.

Design Patterns for Molding Machine

(*Concluded from Page* 470)

in position. A 2-inch diameter upright runner is fixed approximately in the center of the pattern and forms a continuation of the upright runner used in the cope as shown in Fig. 13. Two horizontal steel strips ¼ x 2½ inches extend from the center to a point outside the cast iron cradle supporting the aluminum pattern. These strips are tapered toward the edges. The inner end of each is provided with a short tongue which fits into a corresponding recess in the upright member and thus locates it in place and insures a clear passage when it is withdrawn. The outer end carries a conveniently shaped handle by which the strip may be grasped and pulled through the slot in the cradle.

One of the advantages of this style of gate is that it may be removed easily from the casting. In the natural order it will break away clean, but even if a small stump is left it need not be removed. It is located at a point where its presence or absence is immaterial. The feed chamber shown in Fig. 17 is gated in the same manner. Also the section of the fire pot shown in Fig. 23.

Headquarters of the Wm. C. Robinson & Son Co., have been moved from 149 Broadway to 136 Charlton street, New York.

Mechanization
Solves Production Problems In Automotive Foundry

ABOUT two years ago the Nash Motors Co., Kenosha, Wis., found it necessary to institute a new system in the foundry of its Kenosha plant, to increase the production volume of certain of the larger engine castings to meet the growing demand for its cars. In collaboration with the engineers of Palmer Bee, Inc., Detroit, mechanized production units were developed for the production of four castings, the cylinder block, cylinder head, fly wheel, and transmission case. At the same time the core baking, both for these units and for the other castings made in the foundry, was concentrated in a single oven, and also was mechanized. This oven, together with the production units for the cylinder block and cylinder head went into operation about a year and a half ago. The two remaining units, those for the fly wheel and the transmission case, only have been in operation a short time.

Considered as a whole, the installation possesses several rather novel features in construction and operation, and has been productive of some interesting results in increased production and more economical operation. In laying out the production unit, the idea has been to make each one self-contained, that is to say, all the processes involved in making any one casting are concentrated in one location, from preparing the molds to cleaning the finished casting. The various units are also more or less independent in the matter of supplies, each one being provided with its own source of sand, runners, cores, etc. All the units are served with metal from a group of four cupolas, located at a convenient distance from all of them.

Use Antifriction Bearings

One interesting feature is the liberal use of antifriction bearings that has been made, not only in the production units, but also in the core oven conveyor as well. The wheels of all the mold conveyor carriers, the oven conveyor chain hangers, and the wheels of the reciprocating drag conveyors on one of the production units are equipped with bearings manufactured by the Timken Roller Bearing Co., Canton, O. The unusual feature lies in the fact that, aside from the load and speed requirements that must be met, foundry service is particularly hard on antifriction bearings because of the difficulty of protecting them adequately from the all pervading foundry sand. In this particular case closures, and other protective features have been designed that overcome this difficulty, and permit advantage being taken of the power saving characteristics of the bearings. In the case of the core oven, the problem further was complicated by the temperatures encountered which increased the lubrication difficulties. However, this has been taken care of.

Core Oven Is Continuous Type

Since the core oven is unique of its kind, its description might be of interest. The oven is one of the largest that has been installed, the dimensions of the heating chamber being 200 feet long, 17 feet wide, and 10 feet 8 inches high. The oven is fuel fired, the heating chamber being divided into two temperature zones, that at the entering end maintaining a temperature of 250 Fahr. and that at the delivery end 450 degees Fahr. The oven is served by a continuous conveyor chain about 1,000 feet long, suspended from an overhead track by a series of roller bearing hanger trucks, which also serve to support the racks on which the cores are loaded for baking. There are 150 of these racks, each one weighing about 1,500 pounds when loaded to capacity. An idea of the arrangement of the chain and racks may be gained from Fig. 1.

The chain is driven at the rate of about 1 foot a minute by a 5 horsepower motor, operating through a reduction gear and horizontal sprocket. By an arrangement of the chain travel a total baking time of 3½ hours is given each individual rack of cores. On emerging from the oven, the racks are allowed to cool for about an hour before being detached from the chain and delivered, load and all to the unit for which the cores are intended.

This scheme of concentrating the core baking for the whole foundry at one point has resulted in several material advantages, both economical and practical. In the first place, it is conserving of space, as compared to an installation of a number of smaller ovens, each serving a given unit, or units. It represents a saving in the overall initial investment necessary. This applies, not only to the ovens proper, but to the accessory equipment that would be necessary in the case of a unmber of ovens. Labor required is less as aside from that required to load and unload the racks and to give some attention to lubrication labor has almost ceased to be an item in the expense of operating this oven. Also there is an overall saving in fuel, and in power. In the case of a number of smaller ovens with smaller and more frequent charging, considerable heat is wasted during loading and unloading. Also, being equipped with antifriction bearings, the power requirement of the conveyor is much less than would otherwise be the case.

Use Monorail System

In the design of the unit production systems the features of conservation of space, and facility of operation have been given special consideration. The units are grouped so that they can be easily and quickly supplied with metal, cores, or other material by a simple and inexpensive electric monorail crane system. Incidentally a safety device is used on this monorail system which automatically cuts off the current whenever a track switch is open. When the power is cut off, the crane brakes are set, and there is no possibility of a crane running off an open switch. All the units are laid out in the form of a narrow ellipse, with the long axes parallel to the walls of the buliding. Thus much center space is left clear, both for the crane service, the operations of making the smaller castings, and for the storage of materials. All the

accessory apparatus for each unit is located inside the ellipse formed by the mold conveyor tracks, except, in some cases, the cleaning barrel platforms, and the conveyors that serve them. The unit shown in Fig. 2, which is that producing fly wheels, gives a good idea of the arrangement that generally has been adopted.

Since this flywheel unit is fairly typical, both as to arrangement and operation, its description will serve to illustrate the type of procedure that has been adopted in each case, with the exception of a few details. In this particular unit, the circumference of the ellipse formed by the conveyor tracks is 310 feet. The conveyor consists of a series of 69 roller-bearing, double-mold carriers, driven by a 7½ horsepower motor through a reduction gear that gives a conveyor speed of 3 feet per minute. Fig. 2 also shows the construction of the individual carriers, and the means of connecting them together. It will be noted that they are provided with side aprons that deflect spilled sand clear of the wheels, and help to prevent its working its way into the bearing closure.

Method of operation is as follows: The empty drags and copes are lifted from the conveyor by a small hoist, and placed on the pattern stripping machines on the turntable. There are six of these machines, alternating three for the drags and three for the copes, so that three molds are in process at once as may be seen in Fig. 3. The machines are equipped with permanent metal patterns which are raised and lowered by means of a lever. The revolution of the turntable brings the machines under the nozzle of the sand-throwing, molding machine, supplied by the Beardsley & Piper Co., Chicago, where molds are filled. Each mold section, when finished, is lifted off and put in position on a carrier by means of the hoist. A push button station which controls the operation of the turntable driving motor is located within easy reach of the molding machine operator, so that movement of the table can be stopped quickly if desired.

After the molds have traveled a short distance the runners are put in place, and the mold is ready for pouring. Pouring as shown in Fig. 4 is done by hand from a ladle suspended from an overhead track which runs parallel to the conveyor track. When the molds have completed the circuit of the conveyor, a mechanical shakeout hoist lifts the cope and drag respectively and shakes the sand into a receptacle in the floor that opens over a small pan conveyor. The finished casting is dumped upon a flight conveyor that carries it to the tumbling barrel platform to be cleaned. From this platform chutes carry the finished castings outside the building to the trucks which convey them to the place where further work is done on them.

One of the interesting features of the unit is the method by which the sand used in making the molds is reclaimed and returned to service. The sand that is shaken out of the molds, and the surplus that falls through the turntable grating in the process of filling is delivered to a short pan conveyor, which runs across the short axis of the ellipse at the level of the shakeout hoist. From this conveyor the sand, after passing over a magnetic separator to remove all iron particles is delivered to a reciprocating drag conveyor. This conveyor shown in Fig. 5, consists of a series of plates running in a trough, the frame which carries the plates being supported on simple overhead trucks with roller bearing wheels. The whole is driven with a reciprocating motion by 3-horsepower motor, operating a cam and crank.

Mixes the Sand

During its progress through this conveyor the sand is thoroughly mixed, and granulated, and delivered at the end of its travel to an elevator boot. From there it is elevated through about a 25 foot rise, and delivered to a belt conveyor, known as the tempering belt, which carries it back to a hopper located above the molding machine. Thus it makes a complete circuit, and is ready for use again in a short time. Another advantage of the system is that considerable wastage of sand is avoided.

In the case of the transmission case production unit, the construction of the unit proper is similar to that just described, the principal difference being in the physical characteristics

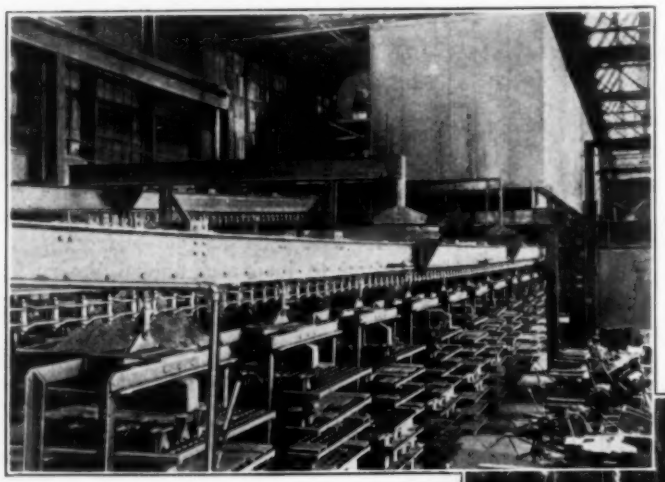
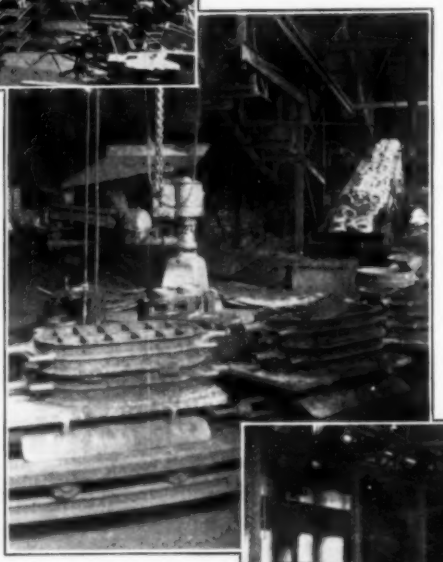


Fig. 1—Left—A Continuous Conveyor Chain 1000 feet long Suspended from Roller Bearing Hanger Trucks Carries the Core Racks into the Oven. The Core Racks when Loaded to Capacity Weigh 1500 Pounds Each



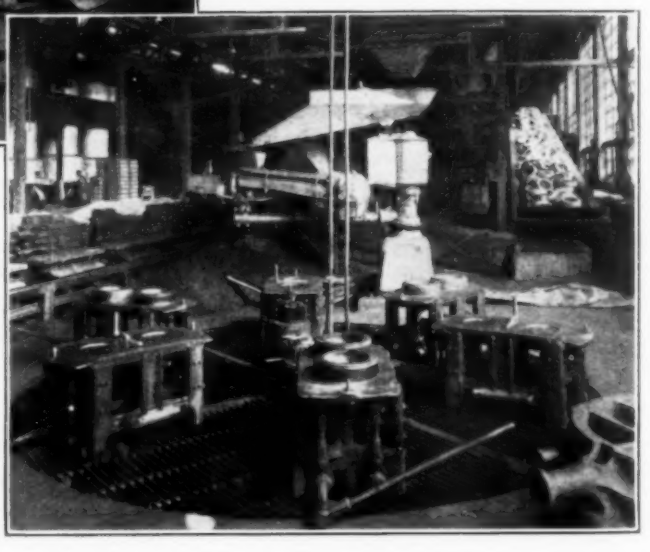


Fig. 2—Above—View of the Fly-wheel Conveyor Unit Showing General Arrangement and Construction of the Individual Carriers. Fig. 3—Right—Turntable, Pattern-stripping and Molding Machines

of the mold conveyor. The ellipse in this case has a circumference of 190 feet, and there are 41 mold carriers in the line with two molds to each carrier. The conveyor speed is about the same. The procedure is also the same, except that after the flask is filled, the core is put in place and fastened in position by hand. The rest of the cycle, including that of reclaiming the sand, is run on the same principle.

Units Are Different

Both the construction of the units and the method of operation differ in the case of the cylinder block and cylinder head conveyors. To conserve space these two units have been mounted concentrically; the cylinder head unit being the smaller is located inside the cylinder block unit. For this reason, they may be considered as one unit, although they have their own individual sand-throwing, molding machines and mold handling apparatus, shakeouts, and conveyors for the finished castings. However, they both are supplied with sand from a common hopper. The cylinder block conveyor line is approximately 369 feet long, and has carriers for 66 molds. It is individually driven by a 10-horsepower motor through reduction gears made by Palmer Bee Inc., Detroit, at a speed of from 54 to 66 inches per minute. Because of the size of the flasks used, it is provided with two turntables, and two sand-throwing machines, one for filling the drag, and the other the cope. Each turntable is equipped with individual hoists for handling its section of the flask off and on the conveyor.

The cylinder head conveyor line, which is inside the cylinder block line, is approximately 235 feet long, and has carriers for 57 molds. It is driven at a speed of 6 feet per minute by an individual 5-horsepower motor. This unit has only one turntable, on which the drag molds are made. The cores, which form the top of the mold, are put in place by hand after the drag has been put on the carrier. At the delivery end of the two conveyor lines are two parallel flight conveyors that carry the castings to two tumbling barrel platforms for cleaning.

The conveyor which carries the head castings is equipped with a hood for practically its entire length that prevents the casting from cooling too rapidly, and thus eliminates future trouble from possible uneven shrinkage. The copes and drags from both units are shaken out over a common grating, and the sand with that which has fallen through the turntable grating goes through a series of reclaiming and tempering conveyors similar to those described previously in the flywheel unit. From this system it is delivered to a storage hopper that forms a common supply for both units. Sand for the two machines of the block unit is delivered from the main hopper by two pan conveyors that dump directly into the hopper.

The results of the installation of these production units on the volume of production and the labor required have been quite remarkable. To take the case of the flywheel unit for example, production has increased 100 per cent, and the amount of labor required has been cut in half. To be specific, the same operations, including cleaning the castings formerly required the services of 30 men, and the maximum production was about

Fig. 5—Below —A Reciprocating Drag Conveyor Carries the Sand from the Magnetic Separator to the Elevator Boot. Fig. 6—Right — Turntables Where Cylinder Blocks Are Made. Sand Is Supplied from One Hopper

Fig. 4—Left— The Molds Are Placed on the Conveyor at the Right Side of This View, the Clamps Wedged on, and After a Short Travel, the Runner Boxes Are Put in Place. The Molds Are Poured at the Left as Shown

600 wheels a 10-hour day. Under the present conditions 16 men can, and do produce 1200 wheels in the same period of time. Practically the same percentages of increased production, and diminished labor charges apply to the other units. The block conveyor has a capacity of 400 castings, with 32 men, as against 75 castings with 12 men formerly required. On the head conveyor, the former figures were 300 castings and 22 men, and are now 400 castings and 12 men. And on the transmission case unit, 125 castings and 14 men, compared to 630 castings and 6 men at present. So that the overall production increase for the whole system averages about 50 per cent or more and the savings in labor about 40 per cent.

Effect Other Savings

Various characteristics of the units themselves also have affected other savings in operating expenses that are difficult to estimate with accuracy, but are nevertheless of material value. For example, there is a considerable saving in the total power demand over what might have been required, because of the liberal use of anti-

friction bearings. These have reduced both the starting and running friction loads of the various conveyors to a point where it has been possible to use motors of a comparatively low horsepower rating. In addition to saving power there has been an additional saving in the investment for motors. In fact, considering the dead weight load of much of the equipment the motor ratings seem almost disproportionately low. The system of sand reclaiming that has been adopted has also been productive of savings by reducing the wastage of sand. In addition, there are the intangible savings that always result from increased convenience of operation, conservation of space, or in fact from all the advantages of mass production by means of centralized unit systems.

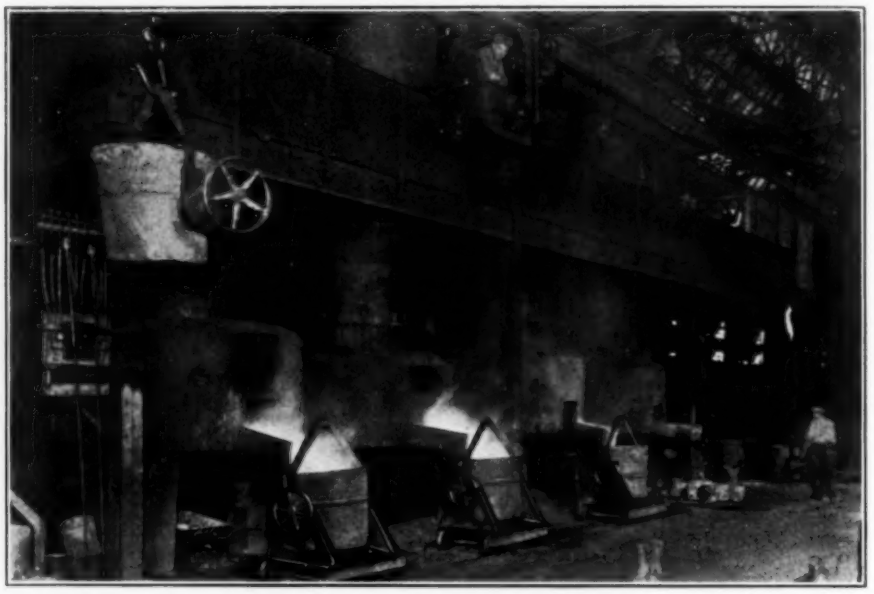


Fig. 7—Four Cupolas Supply Metal for the Various Units. The Metal Is Transported by Monorail Delivery Cranes

Cores Dried Too Quickly

Question: We shall appreciate your opinion on why a small boss on one of our cores always burns when we dry it in an oil-fired oven, while it dries perfectly when the core is placed in an oven fired with coke. To further complicate the situation this boss is located on a part of the core near the center and only 7 inches above the core plate, while another boss only slightly larger in size remains unburned although it is located at the extreme top end of the core 12 inches above the plate. The core is made up of three half cylindrical bodies 4, 10 and 13 inches diameter respectively. The core develops cracks on the heavy end and remains soft and unbaked under the surface.

Answer: The burned core is due to an oven that is raised too rapidly to a maximum temperature. Any kind of fuel may be used in an oven to dry cores, but several contributory factors must be taken into consideration to decide which is the most suitable under a given set of conditions. Irrespective of the fuel employed, one basic factor must be kept in mind and that is that the heat must be applied gradually for the first period. This period will vary depending on the size of the core, the load in the oven, the size of the oven, the principle of ventilation and the volume of water that has to be evaporated. After trying the oven with a series of experimental loads this period may be established with a fair degree of accuracy for succeeding loads. If this natural period is shortened or abridged by forcing the fire, the outside of the core will bake into a crust before the moisture is expelled from the inside. If the temperature is lowered at this point the core eventually will bake all the way through, although at a slower rate than if the preliminary heating had been kept down. If the high temperature is maintained, the outside crust will burn before all the moisture is released from the inside. The fact that the core cracks open on the heavy end indicates that a crust was formed too rapidly on the surface. Slow down your oil burners for the first hour and give the moisture a chance to evaporate before a crust forms on the core.

The Patternmakers association recently has removed its offices from 307 National building, Cleveland, to 309 Superior building, Cleveland.

Retort Casting Shrinks When Poured on End

Question: I am enclosing a sketch of a retort 10 feet in length, with an oval opening 10 inches in the small and 14 inches in the large diameter. The casting is flanged at both ends and is cast in a vertical position. The casting is poured from a low phosphorus iron which usually shows little or no shrinkage. In this particular casting the upper flange shows an abnormal shrinkage. In another heavy casting with a metal thickness of 8 inches I found a flaw resembling a cold shut. This casting was poured from an ordinary foundry gray iron mixture containing pig iron from a certain furnace which often shows this peculiar charactertistic in the castings. I shall appreciate an expression of your opinion on the cause of these two defective castings.

Answer: Without further details of the method of molding and gating the retort casting all we can venture is a guess on the cause of the excessive shrinkage in the upper flange. That guess is that the mold strained under the pressure of the high head and therefore drew the metal away out of the flange. If the casting was poured from the bottom this certainly was the cause.

If the casting was poured from the top, the mold may not have been sufficiently rigid to resist the strain. The obvious remedy is to make the mold in loam or dry sand. If it is made in green sand, then it must be made in a snug fitting flask that will not allow the walls of the mold to *give* beyond a reasonable extent. A row of small pop gates on the top will introduce the metal gently and also will keep it alive on the upward passage and thus prevent cold shuts. At the same time this style of gating will allow the metal on the bottom to set before the mold is filled and thus reduce the strain on the bottom of the mold.

Our guess on the cause of the other defective casting is that it is a cold shut, but we are at a loss to determine whether it is caused by melting the iron too cold or pouring it too slowly. Irons vary in composition to a considerable extent and although two irons may be melted under exactly similar conditions, still one will run much more freely than the other. The remedy of course is to melt the sluggish iron at a higher temperature.

The general offices of the J. J. Mayou Foundry Supply Co., have been moved to 1104 East 47th street, Chicago.

Silicon-Carbon Sum Is Factor in High-Duty Cast Iron Production

By Andre Levi

WHATEVER the processes of manufacture of high-duty cast irons are, production is based on the same principles, and the chemical composition of the resulting iron varies only within small limits from one process to another. The study of the manufacture of semisteel, which was produced in large quantities during the war, throws a light on the study of high-duty cast iron. It was at the time when semisteel was manufactured in large tonnages that methods of control at the cupola by means of chemical analysis and mechanical tests were established and developed and the development of these methods has brought about the present cast irons which give tensile strengths that were unknown before the war.

It has been established definitely that it is possible to obtain a high tensile cast iron in the cupola by charging a mixture of hematite pig iron and steel scrap. There is no difficulty in melting such a mixture, and the consumption of coke ranges between 10 and 12 per cent of the weight of the iron charge. Following a great many tests, Major Prache has established an empirical formula which applies to the manufacture of semisteel in the cupola. These tests have shown that the tensile strength of the test pieces generally varies inversely to silicon-carbon total or total carbon plus silicon. It is further shown that tensile strengths amounting to about 25 kilos per square millimeter (35,558 pounds per square inch) only can be obtained if total carbon plus silicon does not exceed 4.6. It is emphasized that this empirical formula applies to semisteels obtained in the cupola by a mixture of hematite pig iron and 20 to 30 per cent of steel. The general method is to modify the silicon content in relation with the thickness of the casting, and it is recalled that for percentages below 3 per cent of silicon the presence of silicon tends to decrease the speed of cooling. It is noted further that whenever a cast iron has been obtained in the cupola, which satisfies the formula, the tensile strength is always over 20 kilos (28,446 pounds), whether the iron has been obtained with or without steel. A tensile strength over 20 kilos may be obtained, providing that the pigs have the required composition and that total carbon plus silicon is not over 4.6. One may use special hematite pig irons or pigs of a special composition.

Experience obtained in the manufacture of semisteel shells has resulted in a formula being applicable to many methods of manufacture; total carbon plus silicon not over 4.6, with combined carbon equal to 0.8, manganese 0.8, and phosphorus less than 0.10.

Is French Paper

This article is abstracted from a paper presented at a meeting of the Association Technique de Fonderie held at Charleville (Ardennes) France. The author is director of the Forges et Fonderies de Saint-Nicolas, and professor at the High School of Foundry, Paris. The paper was published in full in the Bulletin of the Association Technique de Fondrie.

Two questions arise: First, what is the meaning of the figure 4.6 and second, can the results obtained in the manufacture of semisteel shells be applied in the manufacture of engineering castings?

In studying the microstructure of semisteels, Professor Portevin has formulated the following rule: Cast irons, the structure of which is entirely pearlitic and in which the graphite is distributed as fine curved lamellae or as round nodules, give the best mechanical characteristics. In their investigations, Charpy, Grenet, and Howe have compared cast iron to a steel matrix supporting a graphite skeleton, and they have shown that the more resistant matrix is that which is entirely pearlitic, that is, which contains 0.85 of combined carbon. The presence of graphite diminishes the resistance of the iron, but the more the graphite is distributed in the mass and the more homogeneous is this division, the less is the importance of the action of the graphite on the whole.

Thus the problem is to eliminate graphite as much as possible and to obtain its division in fine lamellae. By decreasing the amount of total carbon, the graphite also decreases and the useful section of the resistant matrix increases. The addition of steel is one method of obtaining this lowering of carbon. This decarburization is, however, limited in the first place on account of the lack of fluidity of iron which contains less than 3 per cent total carbon, and in the second place because it is difficult in cupola practice to obtain a composition with less than 3 per cent total carbon. Consequently, 3 per cent of total carbon is the most satisfactory composition to be aimed at in practice. Thus the empirical formula, total carbon plus silicon not to exceed 4.6, results from the fact that to obtain irons containing about 0.8 per cent of combined carbon with from 3 to 3.2 per cent of total carbon, it is necessary that the silicon should vary from 1 to 1.6 per cent according to the thickness of the casting.

The addition of steel is made simply to decrease the carbon in the iron, and any method which brings about this decarburization is equivalent to an addition of steel. It is evident that if the desired final chemical analysis can be obtained by using pigs, the composition of which answers to the formula, the results will be more satisfactory than by adding steel to the charge.

Answering the second question, in the author's opinion the addition of steel to the charge has no bad effects if the melting operation has been performed properly, and many industrial castings, such as cylinders, automobile and even aviation castings, have been made to specification with steel added to the charge.

Certain precautions have to be taken in the melting operation, and the iron must be cast at a high temperature to be sufficiently fluid. Following a number of tests, the phosphorus content has been increased to increase the fluidity of the iron, and it has been found that as much as 0.3 per cent phosphorus considerably increases the fluidity without having much effect on the tensile strength and even on the resistance to shocks. A large number of test

pieces and castings of various weights, containing total carbon 3.20 per cent, silicon 1.6 per cent, manganese 0.7 per cent, sulphur 0.08 per cent, and phosphorus 0.30 per cent, have given a tensile strength above 33 kilos per square millimeter (46,937 pounds per square inch) and a satisfactory resistance to shock. However, in cases where the phosphorus content is between 0.3 and 1 per cent, there should be a modification in the empirical formula, and total carbon plus silicon should be between 4.6 and 5.2 per cent.

Another factor which has an influence on graphitization is the rate of cooling, which can be modified by controlling the difference between the temperature of the metal and the temperature of the mold. This principle is the basis of several processes where the temperature of the molds is controlled in relation to the thickness of the castings, such processes having been patented by Diefeuthaler, Thyssen and others. It also is possible to take advantage of the influence of silicon, and high silicon cast irons have been successfully used in the manufacture of heat-resisting irons.

All the above methods are based on the principle of decarburization. Other methods have been tried, and in America it has been attempted to make special additions, chromium, for example. These additions can affect the formation of the graphite, but to obtain satisfactory results it is necessary that the castings be heat-treated, but the presence of graphite limits the heat-treating possibilities. Another objection to these additions is that they increase the cost of production considerably and they are only economical in districts where it is possible to utilize iron ore which already contains the special metals for making pig iron.

The author then raises the question of the origin of the pig iron and heredity. There are many cases where two irons of different compositions give the same mechanical results. Is it not true that certain irons always give good results owing to their origin or to their method of preparation? The author replies in the affirmative and states that charcoal iron containing 3.4 per cent carbon can, after having passed in the cupola, gives the same results and shearing tests as ordinary cast iron containing 3 per cent carbon. It also is recalled that pigs which have been remelted give more satisfactory results than if they are cast direct. The author here recalls the studies of Howe, who stated that the formation of graphite is stimulated by the presence of pre-existing nodules. In the case of charcoal irons, cold-blast irons, and pigs that already have been remelted, the graphite will be entirely dissolved in the cupola, but in the case of ordinary irons, especially those that have been blown hot, part of the graphite will not dissolve in the cupola. If this theory be true, any factor that can activate the dissolution of the graphite should result in the obtention of a better product. One of these factors is the division of the graphite in the finest possible particles, and has been studied in the first part of this paper. Another factor is the increase of temperature, and it is possible in current practice to obtain castings with 30 kilos tensile strength (42,670 pounds) and more by heating the iron at about 1500 degrees. A third process for obtaining dissolution of graphite is the method of agitating the bath, and a number of patents have been taken out covering the process of agitating the metal in the forehearth or in the molds.

Testing Society to Hold Meeting

JUNE 25 to 29 inclusive are the dates announced for the annual meeting of the American Society for Testing Materials, which returns this year to the Chalfont-Haddon Hall hotel, Atlantic City, for its sessions. The provisional program of the meeting promises much in the way of valuable technical information. The opening session Tuesday afternoon will be devoted to the business of the society, the announcement of the election of officers and details of the machinery by which the organization performs its service to industry.

The following have been nominated as officers for the coming year: For president, G. W. Thompson, National Lead Co., Brooklyn; for vice president, K. G. Mackenzie, Texas Co., New York; for members of the executive committee, T. R. Lawson, Rensselaer Polytechnic institute, Troy, N. Y.; H. S. Mattimore, Pennsylvania state highway department, Harrisburg, Pa.; P. D. Merica, International Nickel Co., New York; Tamuel Tobias Wagner, Reading Co., Philadelphia.

The second session to be held Tuesday afternoon, June 26, will be devoted to the study of cast and wrought iron. Papers on the effect of sulphur on iron, the relative merits of centrifugally cast and sand cast pipe, static and fatigue tests of cast iron and various committee reports will render this session of particular interest to gray iron foundrymen.

Tuesday evening will be devoted to methods of testing and appropriate attention will be given to the methods of testing steel, bronze and various other metals. Magnetic testing of steel will feature the session Wednesday morning while the Thursday morning meeting will be devoted to questions of corrosion, fatigue and various properties at elevated temperatures of different metals. Nonferrous metals and alloys will have their innings Thursday night at 8 p. m.

The third Edgar Marburg lecture will be given at 4 p. m. Wednesday by Dr. Frank B. Jewett, who will speak on research problems involved in transoceanic telephony. The president, H. F. Moore, University of Illinois, Urbana, Ill., will deliver his annual address Wednesday night, speaking on the subject, "Hooke's Law of Stress and Strain." Monday will be devoted to committee meetings at the headquarters hotel. Reduced fare certificates are available to members of the A. S. T. M. through the office of the secretary, C. L. Warwick, 1315 Spruce street, Philadelphia.

Appointments Are Made

Charles H. Jackson has been promoted to the position of general sales engineer, and Ernest Szekely has been appointed chief engineer by the Bayley Blower Co., Milwaukee. Mr. Jackson formerly was chief engineer and Mr. Szekely who was graduated from the University of Budapest, formerly was associated with the American Blower Co., Detroit; Drying Systems, and for a time had consulting offices in Cleveland.

E. G. Jarvis has been elected chairman of the metal division of the National Association of Waste Material Dealers Inc. Mr. Jarvis also is president of the Niagara Falls Smelting & Refining Corp., and the American Boron Products Co., and chairman of the board of the Ladle Ring Corp. of America.

Cleaning Room Progress Aids Production of Quality Castings

By Frank G. Steinebach

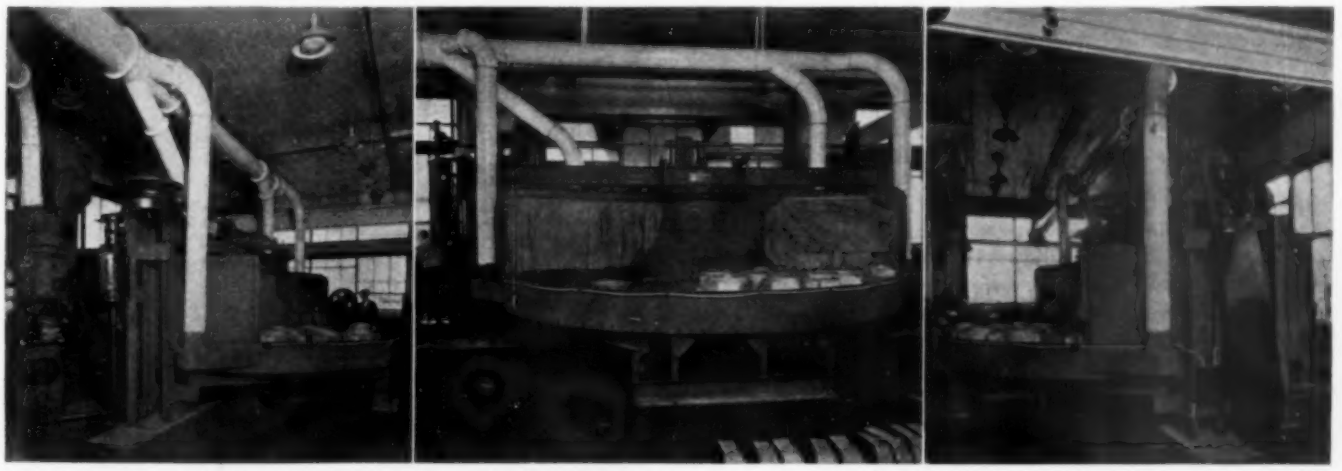
Part VII

APPLICATION of the principles of quantity production in the foundry industry has necessitated many changes in types of equipment employed in production of finished castings. In every foundry department, much has been done to cut manufacturing costs by decreasing the amount of hand labor necessary to turn pig iron and scrap into a marketable product. Molds now are made on machines and carried to the pouring and the shakeout stations by various types of mechanical conveyors. To borrow one of the many slogans created by the manufacturers of food, the sand in many foundries "is not touched by hands" from the time it leaves the shakeout until it is prepared and delivered to the bins above the molders' stations. Many of the problems of handling materials from the storage yard to the charging platform or into the cupola and the difficulties of handling molten metal, have been solved through further application of machinery to foundry operations. In the cleaning room, remarkable strides have been made in reducing the cost of labor and in producing a perfect finish on castings.

However, practically all of these changes in the foundry industry have been made gradually. At study of the advertising and editorial pages of THE FOUNDRY since the first issue in 1892 will show that many of the changes have resulted in the development and perfection of equipment already in use rather than in the introduction of entirely new principles. This fact is borne out especially well in the cleaning room, where a variety of methods and a multiplicity of equipment now is used in placing the finishing touches on the castings.

As the applications of sandblasting increased in the foundry cleaning room, the original equipment not only was greatly improved, but new machines, employing the sandblast idea, were developed. Automatic and semi-automatic mechanisms, included in such equipment, eliminated to a great extent the labor costs involved, speeded the cleaning operations and, perhaps of greatest interest, produced a superior finish. Such machines as the rotary sandblast table and the sandblast tumbling barrel have aided quantity production of certain classes of castings.

The automatic, rotary sandblast table is adapted especially to cleaning castings requiring special care to prevent breakage, as well as flat work and various odd shaped castings, where a sufficient tonnage is cleaned to keep the machine in operation. The general principles of operation are similar in the machines built by the various manufacturers. The equipment consists of a revolving table which carries the castings from the loading station at the front of the machine, through the blasting chamber and back to the front of the machine. The nozzles are fixed in the blasting chamber in a position designed to permit maximum efficiency in blasting and the abrasive is carried from a hopper, into which it falls after the blasting operation,



FIGS. 62, 63 AND 64—FRONT AND SIDE VIEWS OF 18-FOOT ROTARY TABLE MACHINE DESIGNED TO HANDLE LARGE, HEAVY CASTINGS

through the separator and reclaiming equipment and back into the storage hopper.

Operator Loads Table

The greatest amount of labor required in operating this equipment consists in placing the work on the rotary table, turning it over if more than one pass through the blasting chamber is required to clean entirely all parts of the casting, and removing it when the cleaning operation has been completed. The operator places the castings on the table, the number depending upon the size and shape of the pieces. Castings are turned over, to permit complete cleaning, and the finished pieces are removed without

Fig. 66—A Two Nozzle, Suction Feed Rotating Table Designed to Handle Medium Sized Pieces

Fig. 65—A Sight Feed Is Provided on the Gravity Feed Sandblast Machine. The Blast Is Directed Against the Castings Through Three Rotating Nozzles

stopping the table. The table moves slowly, to give ample time for cleaning, so that the operator has no difficulty in loading and unloading the cast parts.

Since numerous differences may be noted in the design of rotary table machines, a rather detailed description of the machines produced by several of the leading manufacturers of that type of equipment should be of interest. A recently developed machine, which contains numerous interesting features, will be discussed first. This machine has a rotary table, 18 feet in diameter, and is designed primarily to handle large castings, such as sanitary ware, sinks, bathtub bases, etc., which are manufactured on a production basis. Front and side views of this machine are shown in Figs. 62, 63 and 64. The equipment may be installed with the table at a bench height, as shown in the accompanying illustrations, in which case no pit is required. However, where the machine is to be used to clean large, heavy castings, it may be more desirable to have the top of the table level with the cleaning room floor, and in the latter case a pit 3 feet 2 inches deep is required.

The table is supported by a heavy vertical shaft which runs on ball bearings at the top and bottom supports. The table is constructed of structural shaped and removable wear plates. The top of the table is built in sections of grated plates. The rotating motion is secured through an internal gear and pinion mounted underneath. About one-third of the table is exposed, to permit loading and unloading, the remainder being enclosed in a heavy steel housing. This housing also is protected from abrasion by renewable wear plates. A multiple, sectional rubber curtain confines the flying abrasive and dust to the blasting chamber.

After the castings to be cleaned pass through the rubber curtain, they are carried under the nozzle manifold,

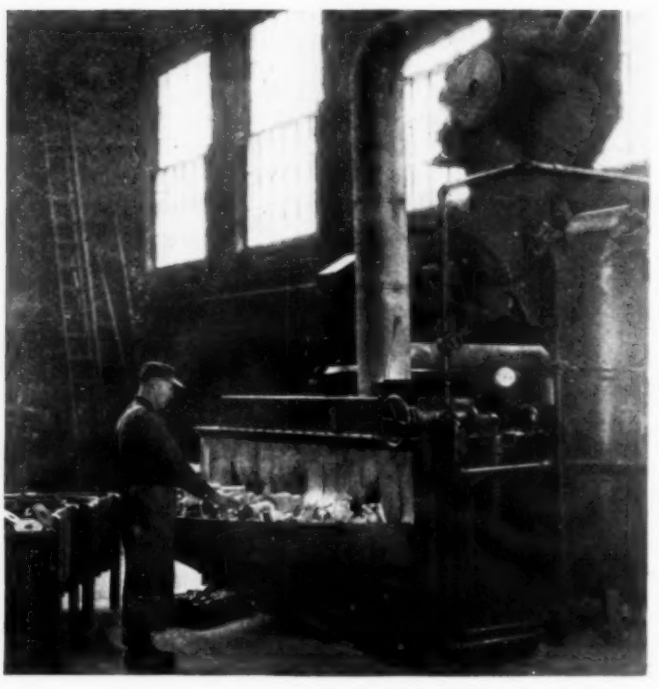


Fig. 67—A Rotary Table Sandblast Machine Equipped With a Positive Pressure Tank and with Elevator to Handle the Abrasive

which is equipped with four nozzle heads. Each head may be equipped with one or more nozzles, as the occasion may demand. An oscillating nozzle may be installed on this type of machine to increase the cleaning area. A direct pressure type sandblast unit is used on this machine. Used abrasive falls through the openings in the table into troughs and is carried to a spiral conveyor below the machine. The spiral conveyor carries the abrasive to the elevator which raises the material and discharges it into a combined mechanical and pneumatic separator. The usable material is separated from the fine dust by vibrating screens, the former being returned to the storage bin and the latter being carried away by the dust collecting system.

The same manufacturer also builds a line of smaller rotating table machines either of the suction feed type or the gravity feed type. An example of the suction feed type is shown in Fig. 66. The blasting unit in that type of equipment consists of two nozzles which are mounted on an oscillating arm and travel across the blasting zone. The used abrasive falls through the table gratings into a hopper below. This hopper has two feed boxes, one for each nozzle, and a screen in the hopper prevents large material from entering the feed boxes.

A view of the gravity feed type machine is shown in Fig. 65. As may be noted in the illustration, a part of the equipment handling the abrasive is located on the outside of the unit. Castings are carried on the rotary table to the blasting compartment within the machine housing. Here three nozzles rotate at varying speeds to direct a blast upon the castings. Used abrasive is carried from below the rotary table to the elevator, where it is raised to the abrasive separator. The usable abrasive passes from the storage bin to the mixing chambers in a sight feed.

Requires No Pit

Another manufacturer specializes in a gravity feed type unit of compact construction which requires no pit or special foundation. The unit consists of a rotary table 8 feet in diameter which is supported by a special shaft. The table consists of eight sections of perforated, cast-iron plates which may be removed easily. About two thirds of the table is covered by a housing, which is of structural steel and divided into three compartments by rubber curtains. The blast is applied by three rotating nozzles located in the back compartment in the housing. The table revolves at approximately 1/3 revolution per minute.

Power for the table, the abrasive elevator and the nozzles is supplied by a single motor. The abrasive is

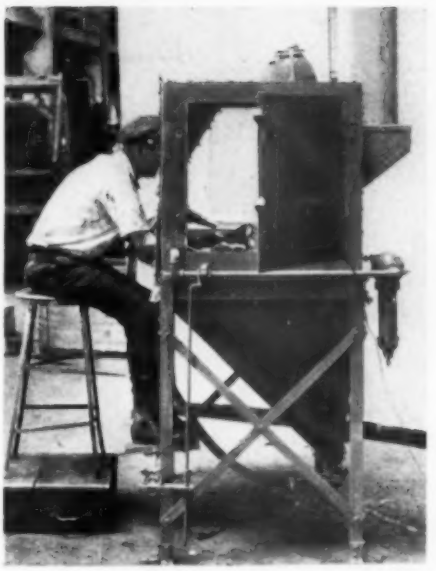


FIG. 69—SANDBLAST CABINET WITH THE DOORS OPEN TO SHOW THE INTERIOR

fed from the storage hopper into the nozzles through adjustable sight feeds. The used abrasive falls through the table gratings into a pan, and is carried to the elevator boot by special steel wipers which are mounted on the under side of the rotary table. The material is elevated in a bucket type elevator, and is passed through a pneumatic separator, over an adjustable screen and into the storage hopper. A double, perforated, cast-iron plate in the feed hopper prevents large refuse from entering the elevator, and the rotary screen at the elevator discharge removes the fine refuse. The company also makes a similar rotary table equipped with a positive pressure unit, mechanical equipment for elevating the abrasive, etc., as shown in Fig. 67.

Both gravity and pressure type machines are built by still another manufacturer. An example of the gravity type of equipment is shown in Fig. 68. These units have a steel housing which forms the blasting chamber. The inside of the blast chamber is lined with rubber sheeting to protect the housing from the action of the blast. The table is constructed of cast-iron gratings made in removable sections and supported by a central shaft. This shaft rests on a ball thrust bearing and is held by roller bearings. Sand is carried down a chute, as it falls through the grating, to a bucket chain elevator. It is carried by the elevator to the top of the reclaiming mechanism, where it is dumped and then is fed downward through screens into the mixing apparatus. Dust is removed from the elevator housing through an exhaust dust port, while two ports remove the dust from the blasting chamber as soon as it is formed in the operation.

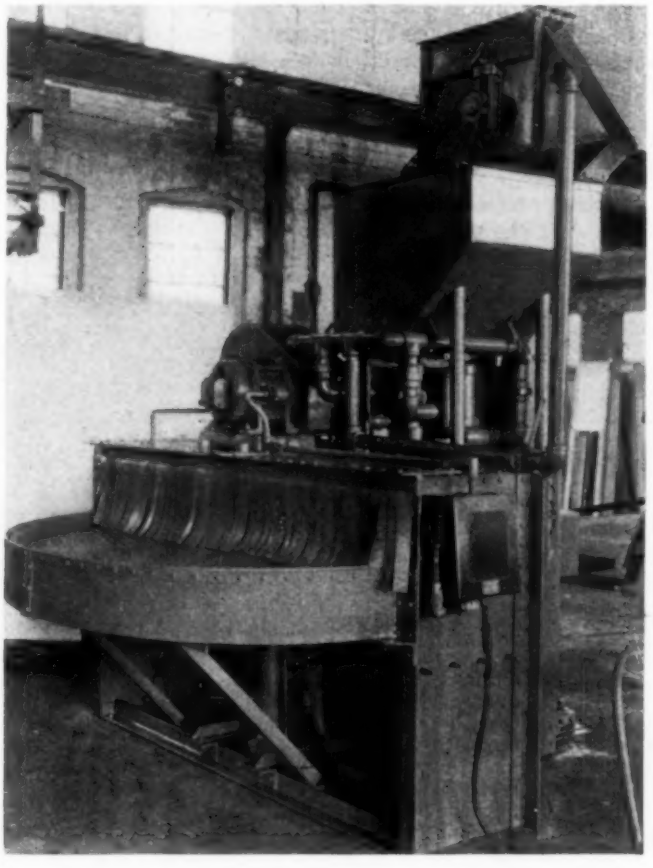


Fig. 68—A Gravity Type Unit Showing a Portion of the Equipment For Handling the Abrasive

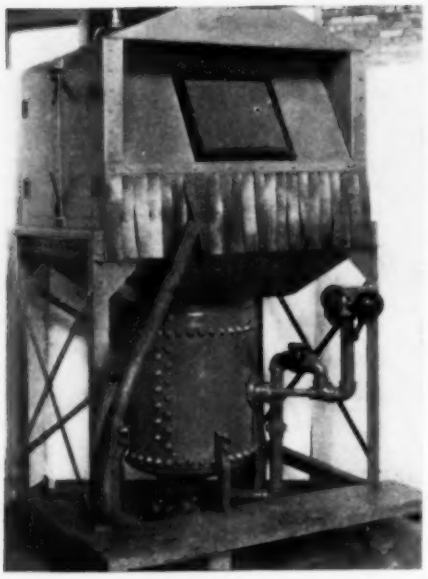


FIG. 70—CABINET HAVING THE PRESSURE TANK LOCATED BELOW THE UNIT

Blast is carried to the castings on the table through several inclined nozzles. Four nozzles are provided on the 84-inch table machine and two on the 48-inch table machine. These nozzles are carried on a revolving head high enough above the table to clear the work. The head revolves in such a manner that all castings on the table are blasted uniformly. Power for operating this unit is applied from a line shaft or motor to a clutch pulley. The pulley shaft drives the bucket elevator and is connected by belt with a fixed countershaft which distributes the power to operate the nozzles and the rotary table.

Uses Two Tanks

In the pressure type machine the sand falls through the table gratings and into a hopper. This hopper is connected with two pressure tanks located in a pit beneath the machine. Each tank has a blast line leading to the two nozzles, and one tank is filled automatically while the other tank is supplying sand to the nozzles. The pressure type machine permits the use of high blast pressures. Power for this type of machine is supplied by a motor mounted on top of the machine and connected to the table, and the oscillating arms of the nozzle.

A number of types of sandblast cabinets now are available. Equipment of this type is designed primarily for small or medium sized castings which must be blasted by hand, either because of the intricate or delicate nature of the casting to be cleaned or the desire for a special finished surface. In the main, this type of equipment consists of a sheet steel cabinet having either a stationary or movable nozzle. One or more openings in the front of the cabinet permit the handling of the casting under the blast. This opening is equipped with sleeves to protect the operator from flying particles and retain rebounding particles of abrasive. A window is constructed above the opening in the cabinet to permit a clear view of the work and an electric light is placed on the inside of the cabinet to illuminate the interior. A door is provided for placing the work in the cabinet and for removing it after the cleaning has been completed. The blast usually is controlled by some type of foot pedal, although other methods are used. A view of a cabinet with the sides removed is shown in Fig. 69. A cabinet, showing the door for loading and unloading, the window, the opening for the operator's arms and the pressure tank below, is illustrated in Fig. 70.

An interesting type of cabinet, which is built in a rather large size for that type of equipment, and which utilizes a turntable to carry the castings into the cabinet and to remove them, is shown in Fig. 71. The work to be cleaned is placed on the turntable, which then is turned one half a revolution, placing the pieces inside the cabinet. The blast stream then is applied through a hose controlled by an operator on the other side of the machine. The room is equipped with the opening for the operator's arms and the windows. The cabinet may be built without a pit, as shown in Fig. 71, or with a table mounted on a revolving hopper which is placed in a pit below the machine.

The spent abrasive is carried to the bucket elevator by a screw conveyor and is elevated in malleable iron buckets mounted on a rubber belt. Abrasive from the buckets passes through a set of pneumatic baffle plates into a pneumatic separator. The fine dust and dirt is removed by air suction and the usable abrasive is placed in a hopper above the pressure tank. A release valve is provided to release the pressure in the tank when new abrasive is added.

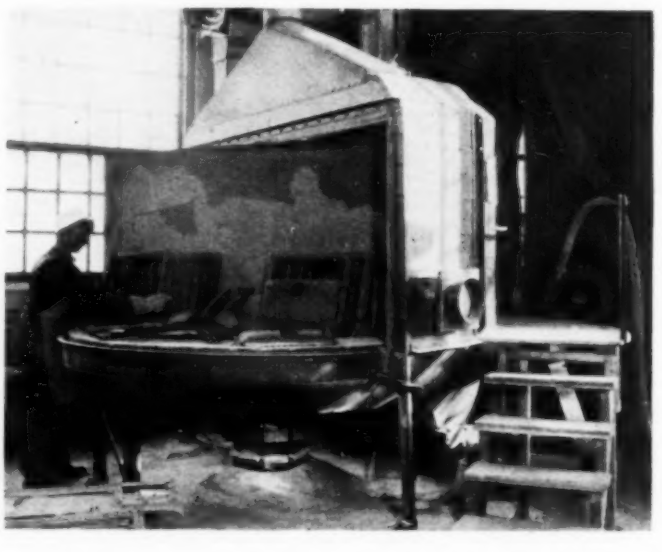


Fig. 71 — Sandblast Cabinet with Turntable To Place Castings Inside the Cabinet

A. B. P. Honors Executive of The Foundry

C. J. Stark, president of the Penton Publishing Co., Cleveland, publisher of THE FOUNDRY and other business papers, was elected president of the Associated Business Papers, Inc., at the fourth annual meeting held at Shawnee-on-Delaware, Pa., May 23-25. Other officers elected are as follows: Vice president, C. A. Musselman, president, Chilton Class Journal Co., Philadelphia; treasurer, Edward H. Ahrens, president, Ahrens Publishing Co., New York. F. M. Feiker, New York, again is managing director and secretary.

The executive committee of the association includes the officers and Mr. Bragdon, Paul I. Aldrich, National Provisioner Inc., Chicago; L. B. Sherman, Simmons-Boardman Publishing Co., Chicago; Elbert E. Haight, Concrete Publishing Co., Chicago; H. T. Hunter, Maclean Publishing Co., Toronto, and James H. McGraw Jr., McGraw-Hill Publishing Co., New York.

Seventy publishers attended the meeting and discussed problems of executive responsibility in the publishing of business papers. J. H. Bragdon, manager, Bragdon, Lord and Nagle, New York, presided at the conference.

Erie City Iron Works, Erie, Pa., has established a sales office at 1105 Leader building, Cleveland. Eugene Smith will be in charge as district manager.

Unexpected Variations *DOMINATE* Steel Casting Practice

By F. A. Melmoth

Part II

RECENTLY the author heard steel castings described by a prominent metallurgist, as, "Badly designed ingots," and believes this to be a definition which, while being somewhat original, is also largely true.

For many years research of the highest order has endeavored to produce orthodox steel ingots which are perfect in all respects, and free even from microscopic imperfections. The author believes it to be a correct statement that the production of the perfect ingot, consistently and commercially, is still an unaccomplished feat. When it is remembered that for the greater part of the steel trades production, ingot design can be varied purely to produce the most ideal ingot, without effect on the ultimate article; but that in the case of a casting its design is fixed by the requirement, and the founder must overcome, so far as he can, any difficulties thus involved, it should be easily appreciated that troubles are likely.

It is this fact which always should influence the designer when considering any new proposition. A realization of the fact that even a symmetrical ingot, well designed, is not free from metallurgical imperfection, to such a person should tend to check undue optimism regarding the production of some of the weird and wonderfully disposed, indeterminate sectioned, masses of metal demanded at times of the modern steel founder.

Laws of liquid and solid contraction are immutable, and the business of the steel founder is to realize them, and take such steps as will, to the greatest possible extent, neutralize their detrimental effect on the casting.

Intelligent performance of this naturally calls for study of the behavior of steel when cooling from the fluid condition in a sand mold, and coincidently a knowledge of steel itself. This point was emphasized as a necessity earlier in the present paper.

As distinct from variables induced by the action of sand molds on liquid steel, a host of factors inherently belonging to the steel itself can produce variations in results, some of which are understood none too well, and often cause mystification, when attempts to allocate causes are made.

The simplest cases are those associated with variations in what might be called orthodox composition. In the case of a plain carbon steel for castings, the effect of variations of combined carbon above or below the normal may be taken as follows:

If too high. Castings short of ductility, probably hard to machine.

Too low. Material soft, but likely to fail to meet specified strength in tensile test. Wearing properties adversely affected.

General behavior of steel in a mold is not affected seriously by comparatively small variations in carbon content. When considered over a wide range of variation, however, the steels possess different characteristics. A high carbon content is coincident with a lower melting point, which necessarily means that at a given temperature such steel is more fluid and easily cast into thin sections than is the case when carbon content is low.

It is the author's opinion also that the lower the carbon content the more difficult it becomes to produce absolute freedom from unsoundness of the porosity type. Low carbon steels appear to have a great capacity for mold gas absorption, intensified, no doubt, by the fact that their high temperature of solidification necessitates an unusually high temperature of casting. Low carbon steels are not remarkable for their fluidity and the author suggests that a low degree of fluidity predisposes to unsoundness in steel for casting in sand molds.

In straight carbon steels the carbon content may be said to be the main controlling factor of the ultimate strength of the material. The series of tests given in Table I will demonstrate this fairly well, the coincident increase of tensile strength and carbon content showing what might be expected from annealed steel castings of these carbon contents, other elements remaining constant.

All the samples were annealed, and slowly cooled in the furnace in order to insure equality of temperature and cooling speeds in all cases.

Test bars in all cases were attached to commercial types of casting, and the treatment being normal may be taken as indicative of the everyday product given similar treatment conditions.

Variations of carbon content outside ordinary manufacturing limits of accuracy are entirely a matter of steel making practice, and are today of rare occurence.

Such variations become matters of importance, even if of comparatively small degree, when they occur in such dead soft steels as are used in the manufacture of various electrical requirements. In these cases a certain demanded degree of magnetic permeability is common, and carbon content has a decided action on this property, increasing carbon progressively lowering the magnetic permeability.

Permeability curves *M* and *M*1 in Figs. 1 and 2 demonstrate this point clearly. It will be seen that the value of magnetic flux *B* in sample represented by Curve *M* is much higher than the one shown by *M*1 at a given value of magnetic field *H*. The analyses of the samples used are given as an explanatory reference:

Sample	Carbon	Silicon	Manganese
M	.....0.12	0.20	0.40
M1	.....0.21	0.20	0.65

The treatment is identical in both

Explains Effects

IN THIS second section of his paper, the author gives the effects and influences of the various elements in steel. He also gives the normal ranges of the elements as encountered in routine steel foundry practice. The third part of the series will follow in an early issue.

cases, being straight annealing at 850 to 900 degrees Cent. followed by slow cooling.

Silicon in ordinary commercial steel castings is almost entirely present in order to assist soundness by the removal of oxide. In normal quantities it may be said to have little effect on the physical properties of the materials. The author's experience would suggest that in excessive quantities there are, however, possibilities of variations being produced in the resulting casting. High silicon in mild steel castings tends to the production of a coarse ferritic structure with consequent lower strength or resistance to shock impact. Several cases of abnormally low yield ratio also have been noted, explainable only by the presence of unusually high silicon content.

However, the main trouble experienced is not one of effect on the ultimate physical properties, but one associated with the behavior of the molten steel in the mold. The author has, in previous papers, emphasized the gas absorption capabilities of mild steels, particularly when produced by the electric process, and subjected to strongly reducing slag action. When thus produced, such steels would appear to possess in an aggravated form the capacity to absorb temporarily, in their passage through the mold, large quantities of evolved mold gases, releasing them with blowhole production, during solidification.

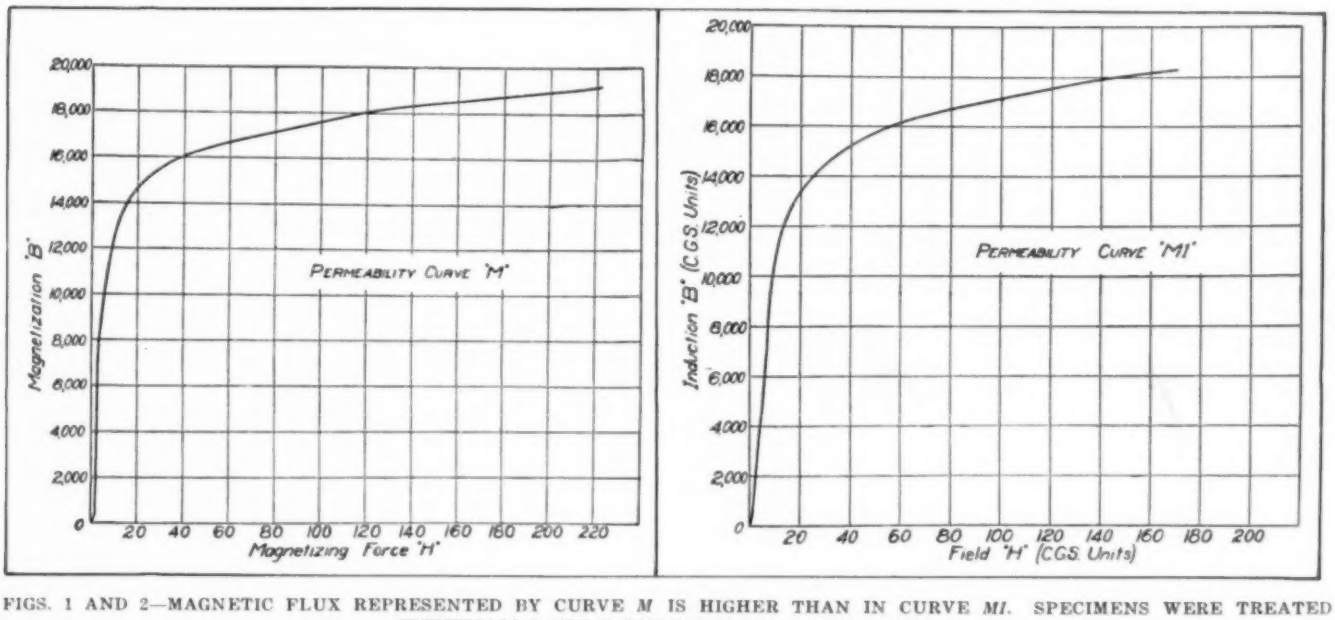
This action would be expected to be governed in degree by the casting temperature of the steel, and this is doubtless to some extent true. In addition, however, the author suggests that high silicon content, with high temperature, tends to produce the most favorable condition for temporary absorption. The effect is most marked in the production of green sand castings of a light type, and the occurrence in practice of repeated unsoundness in such steels would appear to emphasize that silicon variations should be avoided as far as possible.

It is hardly necessary to enlarge on the effect of abnormally low silicon, in the absence of other powerful deoxidizing elements. Free oxide of iron existing in the steel at the time of casting, reacts with the carbon present, and produces *wildness*, in which condition no possibility of a sound casting exists.

The author with G. Batty, has endeavored to associate silicon content with fluidity of the steel as cast. Over a large number of electric furnace casts it strongly is suggested that abnormally high silicon produces a material much more difficult to cast from small shanks, than when silicon content is normal. The principal point observed is the tendency to skin over on the surface of the metal immediately it is exposed to the air. It appears incorrect to state dogmatically that this is due to the direct action of the presence of the silicon, as it may equally be due to the furnace condition which tended toward the production of high silicon content. These charges are frequently dead, and result from strongly reducing conditions. Even when hot they do not exhibit the usual degree of fluidity, and have been designated *dazed* heats. The condition is remediable by a return to oxidizing conditions in the furnace, afterward finishing as usual.

A further peculiarity which might legitimately be included as a silicon variable is the case where silicon content has been affected by a highly siliceous slag being allowed to form on a basic electric charge. This obviously is the result of overheated brickwork, but peculiar effects have been noted, which are worth recording. At high temperature, which certainly is the prime cause of this occurrence, silicon can be reduced from the silicates in the slag and enter the metal. The author is of opinion that it cannot be stated definitely that silicon thus introduced exists in precisely the same state and has the same action as silicon introduced in the orthodox manner as ferrosilicon or silicomanganese. Charges have been noted, fortunately rarely, which thus have been affected, and which have been impossible to quiet by any deoxidizing medium. Their silicon content has been high, occasionally as high as 0.7 to 0.8 per cent, but as soon as cast into the mold they have immediately risen badly. Further treatment in the furnace has no curative effect, but solidification, and remelting appears to remove the trouble. The furnace samples of such charges do not always indicate their character; being perfectly sound, it is suggested therefore that the condition is an exaggerated form of the effect of high silicon and temperature previously referred to, with the possibility of some abnormal association of the silicon content.

Manganese is one of the most important elements found in commercial steels. It follows that variations of a serious order are to be avoided. It functions primarily as a deoxidizer of an efficient type, assisting soundness greatly, particularly in green



FIGS. 1 AND 2—MAGNETIC FLUX REPRESENTED BY CURVE *M* IS HIGHER THAN IN CURVE *M1*. SPECIMENS WERE TREATED IDENTICALLY BUT *M* CONTAINS THE LOWER CARBON

sand castings. It is suggested that this is due to the tendency to enable iron to retain dissolved gases in permanent solution. In this respect its action varies from that of silicon, which, although apparently increasing such solution capability, confines its effects largely to the liquid state; evolution of the dissolved gases taking place in solidification.

Manganese forms a double carbide with iron and has pronounced physical effects in the ultimate casting, apart from its value to the founder as a help in producing sound castings. Tensile strength and yield point are materially increased without any serious loss of ductility, by the presence of a fair percentage. Where castings are required for specially high duty, and quenching and tempering operations are resorted to, a comparatively high percentage of manganese appears to increase considerably the intensity of the quenching action, and remarkable physical properties can be thus attained.

A still further beneficial action of manganese is its effect on the condition of sulphur content. Where the latter is likely to run high, an ample percentage of manganese, by the formation of manganese sulphide, prevents the occurrence of iron sulphide which exists in such a form as to be detrimental to the physical properties of the steel.

Control Manganese Content

The effect of manganese is of course seen to the full in the high manganese-iron alloy known as manganese steel, discovered and developed by Sir Robert Hadfield. In this steel approximately 12 per cent of manganese exists, and given accurate treatment the product possesses strength, resistance to wear, and ductility of an almost amazing order. It is comparatively easy to cast and for parts subjected to the most gruelling of hard wear conditions is probably supreme in its class.

Bearing in mind the many effects of manganese content, it will be obvious that serious variations in the amount of its occurence can considerably affect the properties of the casting. It is fortunately quite a simple matter in all methods of modern steel manufacture to maintain regularity in this element and fluctuations of a serious order are therefore, variables that should not exist in a well managed shop. In ordinary steel castings 0.8 to 1.2 per cent is commonly accepted as normal; variations inside this range being largely a matter of individual opinion.

Sulphur is probably looked upon with more suspicion than any other in a steel casting, and to some extent, this attitude is well founded. If often appears to the author, however, that exaggeration of its effect is a possible feature. Cracks in steel castings often are attributed to this element, which are much more likely to be due to inefficient precautions in the making of the mold.

Table I

Carbon Increases Tensile Strength

Analysis			Max. stress pounds per	Per cent elongation	Per cent reduction of area	Degrees cold bend
Carbon	Silicon	Manganese	square inch	on 2 inches		1"x¾"
0.15	0.20	0.81	62,272	34.0	52.5	180
0.18	0.30	0.83	73,024	34.0	49.0	180
0.26	0.37	0.84	74,816	33.0	54.2	180
0.35	0.38	0.79	85,408	24.0	44.5	180
0.46	0.28	0.73	93,184	22.0	33.6	Not taken

Not Always To Blame

It was not uncommon, before the advance of metallurgical knowledge made it impossible, for the founder to turn a suspicious eye on his metal as a possible cause of any unexpected variation, or trouble with a casting. The admittedly detrimental effect of really high sulphur content would make it easy to exaggerate the effect of quite small and unimportant variations. Such a state of affairs was doubtless convenient to the molder, but it generally is admitted that in the presence of a reasonably high manganese content, sulphur content of an amount usually present in steel castings is unlikely to be the cause of serious trouble, either from the point of view of casting cracks, or effect on ultimate physical properties.

Low maximum limits placed on this element by many specifications undoubtedly have assisted toward a magnified conception of its ill effects.

It is not intended by this statement to infer that sulphur is not detrimental if present in abnormal percentage. Steel is definitely red short if it contains a high percentage of sulphur, and therefore prone to cracks when subjected to contraction resistance while cooling from the molten condition.

Serious variations on the high side should be avoided, and present steelmaking methods easily are able to guarantee a sulphur content of an order impossible to associate with trouble in the casting. Where acid processes are the rule this entails care in the choosing of materials, and an organized analytical checking system as no refining action is possible. Where basic lined furnaces are used, sulphur easily can be removed to almost traces and no danger should exist of serious variation.

It is generally accepted that 0.06 per cent can be taken as a perfectly safe upper limit.

Phosphorus is often associated with sulphur in the degree of suspicion with which it is regarded. In excessive amounts its action can be taken as being a tendency to reduce resistance to shock. Its effect on general physical properties does not appear important in normal amounts. In steel it exists in such comparatively small amounts that it also exerts no influence on the behavior of the metal in the molds. The author has heard the opinion expressed on many occasions that a variation even from 0.03 to 0.06 per cent accounts for a marked increase in the degree of fluidity of the metal. However, he has no evidence to confirm this as a result of his observations, and is more of the opinion that the increased fluidity was a direct outcome of the melting conditions which coincidently produced a higher phosphorus. As an instance, one might quote the cases of electric steel made by single and double slag processes. The fluidity of the former is almost invariably higher, and its phosphorus content also will be higher. On the other hand, by so treating the single slag as to produce strongly reducing conditions the advantage in fluidity certainly can be removed, although the phosphorus content will remain the same.

Gives Phosphorus Limit

Working with an upper limit of 0.06 to 0.07 per cent the author has detected no detrimental effect.

To prevent variation in this element the precautions naturally vary according to the steelmaking method employed, and are the same as those noted for sulphur.

A factor which might be considered under the heading of steelmaking variables is that of the influence of steelmaking process.

Theoretically it might be assumed that steels of equal general composition should behave similarly, and give comparable results in the product, irrespective of the process by

which the steels are made. Practical experience of material produced by various processes suggests, however, that this is not the case. It appears to the author that this might be taken as a variable to be considered where steel processes are liable to undergo a change in type.

For heavy work, the Siemens open-hearth furnace practically monopolizes the demand, being the only type of furnace at present capable of producing commercially large enough single charges. It is therefore more in the direction of the medium and lighter classes of casting that variations of steelmaking process are likely to occur.

The general opinion of many steel foundrymen would suggest that the main point of variation is in the actual behavior of the steels during casting, that is, in their comparative degree of fluidity, which mainly controls the ease with which a steel casting can be run. In the author's opinion, which is based on observation over large quantities of steel of each type, the following would represent the order of the various steelmaking processes based on their comparative ability to produce steel with a degree of fluidity high in proportion to its temperature. The crucible is omitted owing to the comparative infrequency of its use at the present time.

Converter
Electric furnace (single slag)
Siemens open hearth
Electric furnace (double slag)

In placing electrically produced double slagged steel at the bottom of the list, the author probably will meet with a good deal of opposition. He would emphasize, however, that the steel he has in mind, classified as low in fluidity, is that produced when the bath is subjected to the action of strongly reducing slags, for considerable periods. When this is the practice the author has always found that to a greater or less extent, depending on degree and time of the action, fluidity is lessened markedly, and it consequently becomes more difficult to run light sections.

Various suggested explanations have been forthcoming from time to time, to account for this variation, and also that frequently claimed between electric and converter produced steels of the same analysis. The author's opinion and tentative suggestions were set forth in a paper given to the Manchester branch of the Institute of British Foundrymen some time ago, and in order not to unduly prolong the present paper he would refer those interested to this publication. It will perhaps suffice to say that the author has seen no reason to modify seriously his opinion since the date of the paper referred to.

A good deal can be said with regard to the influence of steelmaking process on the regularity of the composition of the castings produced. The electric furnace with a basic hearth stands pre-eminent in this respect, its freedom from slag losses making it a fairly simple matter to maintain regularity of analysis well within practical limits.

Pencil Gates Used with Shaft Couplings

Question: We are making shaft couplings varing in weight from 10 to 350 pounds and find cavities in the opening after the boring tool has passed through. In an effort to prevent this condition we have added 20 per cent steel to the cupola charge and have used chills in connection with the center core. We attempt to feed the large castings, but note that the iron backs up into the riser. We have tried every method suggested by a rather lengthy experience, but without success and will appreciate your opinion on the probable cause of the trouble.

Answer: We hesitate to venture an opinion first because you do not supply any detail of your present molding and pouring methods and second, since you have tried every method suggested by experience, it is apparent that your trouble must be due to some obscure cause. Therefore, instead of speculating on the probable cause of the cavities and attempting to find the exact one by a species of elimination, we shall outline briefly the proper manner in which these castings should be molded and poured.

Most of the porosity in these castings is caused by gas developed during the pouring process. The shape of the casting promotes the formation of more gas than usual, therefore the aim of the molder should be to make a mold in which the gas can escape readily and then pour the mold so slowly that all the gas has a chance to escape before the metal solidifies. In many plants all couplings are made in dry sand molds to eliminate the gas hazard. However if proper precautions are observed the castings may be molded in green sand. The shoulder of sand where the web joins the hub is the danger point and should be rammed softly and well vented. Also, the sand should be worked as dry as possible. The center core simply should be a shell instead of the usual solid block of sand. By observing these precautions the iron will lie quietly in the mold.

The second most important feature is to pour the iron so that it will be clean and at the same time fill the mold slowly and steadily. Both these important points are observed by pouring the iron through a ring of pencil gates over the hub of the casting. The number of gates will depend on the weight of the casting. For example two ¼-inch diameter gates will be sufficient on a 10-pound casting, while 12 gates the same size or a little larger will be needed for the 350-pound casting.

In a paper presented before the Institute of British Foundrymen in 1922 E. Ronceray described a method of securing solid, homogenous castings by pouring them from the bottom through exceedingly small runners. This paper was published in THE FOUNDRY, Oct. 15, 1922. Among the illustrations was a shaft coupling 14 inches diameter. This was poured through a vertical runner ½-inch square extending almost to the bottom of the center core where it was connected to two branches ¼-inch square on the inside of the hub. We have no personal knowledge of this method, but it appeals strongly to us and if we had the opportunity we should try it.

British Institute to Meet in United States

At the recent general meeting of the British Institute of Metals held in London, England, May 8, W. M. Corse, honorary corresponding member to the council for United States, presented on behalf of the American Institute of Mining and Metallurgical Engineers, an invitation to the British institute to meet with the American institute in 1932. It is expected that a good representation of the British institute will be present at the proposed meeting in the United States due to the ample notice. The trip including the meeting is expected to be about five weeks duration and will take place in the autumn, both United States and Canada being visited.

Recently the British Airships Ltd. has acquired world rights for a new method of coating materials with metals. The process consists in applying a preparation to the material which renders it conductive and then it is plated. It is claimed that by this process wood, cloth and other non-conductive materials can be plated satisfactorily.

Bill Touches on Some Problems in Molding-VII

By Pat Dwyer

LAST Saturday I was obliged to remain down town for a few hours in the afternoon. When the hour of high noon arrived I debated earnestly whether I should sally forth for an hour and wrap myself around a noble lunch, or stay where I was, finish the job on which I was engaged and then toddle off home to see if anything had been left for me.

The situation presented many interesting angles with the arguments nearly balanced on both sides. Had I been broke the situation automatically would have solved itself, but a tentative exploring trip in the pocket where some times I park a small quantity of filthy lucre showed that I was in no immediate danger of coming to grips with the dread spectre of starvation. This factor coupled with the sage reflection that a bird in the hand or even on the table within easy reach, is better than fourteen Plymouth Rocks on the hoof and covered with dense layers of feathers, finally weighed the scale down on one side. I put away the tools, folded the overalls carefully to preserve the creases and seizing the figurative bow and arrow, sallied forth into the jungle to make a kill.

On the way to a favorite water hole where on sundry and divers former occasions I had found the quarry and assuaged the pangs of hunger, I had to pass through a great open space ornamented in the center by a monument erected to the memory of the men from Ohio who had served in the sea and land forces of the United States from '61 to '65. Heroic groups of bronze statuary near the base on each of the four sides of the monument often have attracted my attention on the return journey, when I am filled to repletion and consequently in an appreciative and contemplative mood. More pressing matters engage my attention when I am bent on a foraging expedition. I have no time to waste on sight seeing. Self preservation comes first. The mind can jolly well take a back seat and wait its turn. A man is composed of body and mind and theoretically the mind is the more important partner, but, as in many other forms of partnership, the partner who makes the most noise gets the most attention. The mind may be engaged in the most engrossing occupation to the exclusion of all thought of time, but when the hungry body wants food, it sets up a clamor that refuses to be stilled, that will listen to no argument until its wants are met.

On this momentous occasion I was hurrying past the monument, stretching the little bandy legs to the elastic limit, with only one thought in mind, to cover a given distance in a minimum period of time. I would not have stopped to admire the groups of statuary if they had been cast in pure gold with sapphires in the eye sockets and emerald rings on their fingers and toes. The figures had been there for years and probably still will be holding their heroic pose years after I have been forgotten by even my dearest enemies. I wish I had some assurance that I will be allowed to come back to haunt some of these birds. I have certain pet plans I should like to try out—.

However, that is another subject. Perhaps I should not mention it since the element of surprise is one of the most potent factors, in fact one of the absolutely essential factors required in putting across a good hair raising, spooky, haunting act. Unless the victim is shocked stiff at the outset, the remainder of the act may fall flat. Bill reminded me of this feature.

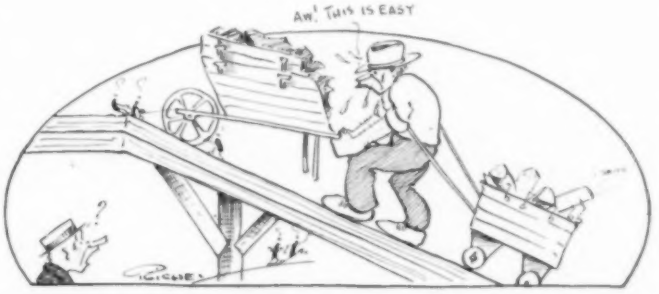
I found him standing in front of the monument on the north side, gazing reflectively at the *Color Guard*.

"Halt!" said he, bringing an imaginary musket to the ready. "Who goes there? What's all the rush, where are you going and what's the pass word?"

"One side fella!" I hissed. A rather remarkable feat and one I might say in passing altogether outside the vocal range of any person who never has been chased by an angry gander. Query: Why are ganders so irritable, so pugnacious, so anxious, dying you might say, to bite a person?

"Gangway!" I continued, "you are toying with sudden and violent death. In a word my lad you are standing between a hungry man and his dinner." Bill received the important announcement with careless indifference.

"You need not eat me," he said. "The word for the day is 'eat' and you seem to have it O. K., but just to make sure I shall accompany you to headquarters. Your apologies are accepted in the same generous and handsome spirit in which they are tendered. I shall be happy to accept



FROM ALGER'S *PUSH AND PULL OR BOUND TO RISE*

your kind invitation to take lunch with you. In fact," he continued with a fine open handed gesture, "I'll tell you what I'll do. I'll waive all the rights and privileges of an invited guest and match you for the check. I'll toss up heads or tails, odd or even, cut the cards, roll the bones or shoot you a game of pool to settle the point. Nothing could be fairer than that."

"Come on," I said, "and don't stand here all day prattling."

After the meal, Bill produced a couple of stogies and then proposed we shoot a little pool. I admitted that the offer appealed to me, but unfortunately I was a down trodden working man, singled out by a cruel fate to toil for a living. I was in constant and imminent danger of being crushed between two economic mill stones. If I did not work, I could not eat and if I did not eat I could not work. Therefore while the flesh leaned heavily toward the alluring idea of dallying with the cues for an hour or two, the stern and uncompromising spirit shouted, "Back to the mines."

Bill failed to rally to the support of the good old party. In fact he remarked rudely that I made him tired. Now, I ask you was that nice?

"Work," he sniffed. "Nothing but work all the time. Where does it get you? Lay off once in a while and have a little fun. I suppose you think the world will stop when you stop. Lissen, young fellame-lad, the work of the world was going on quite nicely before you were born and it will continue after you have killed yourself hopping on the treadmill."

"Now that is a curious coincidence," I said. "Just before I met you I was dwelling with a considerable degree of gratification on the thought that perhaps after I had settled permanently on the other shore I might be allowed to come back occasionally to haunt a few lads I wot of; to kind of even up a few little scores which I never have had an opportunity of settling properly."

"Don't make a silly mistake of that kind," Bill implored me. "Never put off 'till tomorrow the belt you can land a fellow today. Did I ever tell you about Joe Elliott and the ghost? No? Well this is as good a time as any other. Your case and Joe's are not exactly parallel, but the deep moral lesson of the story is that it does not pay to act the ghost. No, not goat. I said ghost.

"Joe was the husky young cupola man in the shop where I served my time. When I say husky I mean strong and tough and then some over for good measure. The daily heat ran from four to five tons and Joe did all the work himself from chipping her down in the morning to tapping her out at night. He had to wheel all the stuff from the stockyard up a long plank incline to the charging floor of the little cupola.

'TWAS A BALMY SUMMER EVENING AND A GOODLY CROWD WAS THERE

"During the course of a long and fairly carefree lifetime, as lifetimes go, I have seen many wheelbarrow artists, but never a one like Joe. His usual load of pig or scrap was 700 pounds. One day over a bet which involved a four-cent plug of Montreal twist, he wheeled a load of 1000 pounds of pig iron up that 25 per cent grade almost as readily as I could push an empty barrow. The lad who challenged him could not lift the legs of the barrow from the ground.

"You should have seen him breaking pig iron. He became right peeved if he had to hit a pig more than once. His predecessor used a fairly large barrow for wheeling the coke, but Joe rigged a wooden upset about two feet high on the thing and ran enough coke up in three or four trips to run off the heat. The cupola was only 30 inches on the inside and Joe practically filled it while he worked on the repairs. After the daubing was applied he turned himself around two or three times and polished the mud as smooth and round as the inside of a robin's nest.

"He was a quiet and friendly lad and made no boast of his strength except Saturday night. He commenced by breaking a noble statute which prohibited the sale of spirituous and malt liquors in one of the oversea colonies which owed allegiance to her most gracious majesty, Queen Victoria, of happy memory.

"Joe harbored no grudge against her majesty or against her colonial government. In fact he cheerfully would knock the block off any person who said a word against either one or the other. He was as patriotic as the next man and never failed to march, properly fortified, in the twelfth of July parade. On Saturday night he usually quaffed a few beakers to the health of the queen and confusion to her enemies. Naturally in a mixed crowd one or two gentlemen failed to see eye to eye with Mr. Elliott on this important subject and that gave him an excuse to exercise some of his latent energy. He leaned heavily on some of these gentlemen on sundry and divers occasions and as a result a few of them decided to give him a little jolt. Not to actually kill or even cripple him, but as one explained 'just scare him stiff and put a little of the fear of God in his big carcass.'

"Several schemes were considered in detail, but were discarded as impractical, principally because they involved too great an element of risk to the physical well being of the party of the second part. Finally they hit upon one which promised to cover the situation as neatly as the paper on the wall.

"Joe was accustomed to visit his lady love on Sunday night. A short cut on the return journey carried him through a cemetery. A scouting expedition of the enemy one Sunday afternoon showed a newly excavated grave close to the path and this furnished the inspiration for the scheme which they hoped would even up some of the old scores against our hero.

"Members of the party repaired to the cemetery about 11 p. m. Here they enveloped themselves in white sheets to create the proper impression and screwed their courage to the sticking point with a few drafts of

red Demarara rum which one of the party thoughtfully had provided. A cold wind and a drizzling rain added nothing to their pleasure. The spooky atmosphere was beginning to affect their nerves. The bottle was empty and their courage slowly ebbing. Each one of the party accused the others of starting the silly expedition and a free fight only was averted by the sight and sound of Joe approaching. They ducked for cover and waited for the great moment.

"Joe strode along blithely, his mind in a seventh heaven of delight, dwelling fondly on the manifold charms of the little lady from whom he just had parted reluctantly. He weighed every word, every action and began to wonder if his wooing had progressed far enough to justify him in asking the angel a certain question.

"Naturally this started him off on a new tangent and he heartily cursed himself for playing hookey from school in his young days instead of practicing up on the English language. The problem of framing the question in words appropriate to the momentous occasion occupied his mind to such an extent that he failed to see the yawning cavity in the earth. Only his surprising and catlike agility in the last fraction of a second enabled him to jump and land on his feet instead of breaking his neck.

"He scrambled out to be confronted by a tall chilly figure in white who demanded in sepulchral tones: 'What are you doing in my grave?'

"Joe's early schooling had taught him little of the language of love, but as a compensating measure had qualified him fully in the language of war.

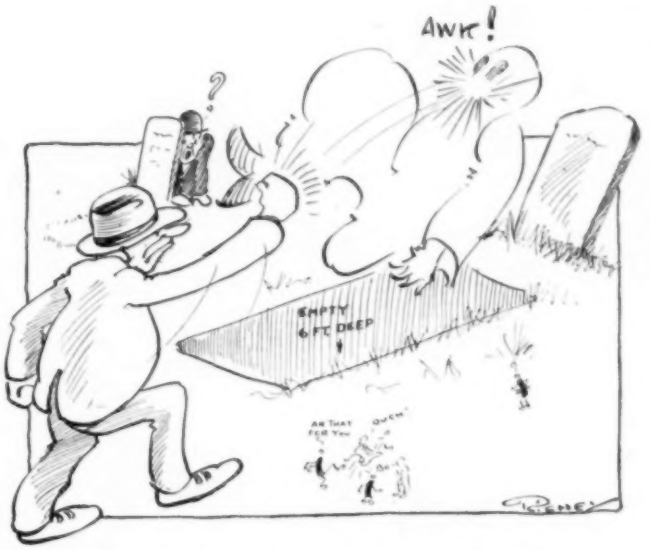
"'Who, me?'" said he, "'I was just warming it up for you. Into your nest!'

"Before the surprised ghost could jump or raise a hand, Joe hit him a belt on the jaw that lifted him two feet from the ground and landed him in a crumpled heap in the bottom of the grave.

"Talking about graves and excavations of one kind or another of a somewhat similar character," Bill continued, "reminds me of a few more comments I intended to make on the various methods of molding a trough casting. The last time I saw you I was talking of the necessity of lifting the core plumb.

"Observance of this plumb rule also is essential in suspending the core from the crane either in lifting it out of the mold or in replacing it. Two main reasons render this observance imperative. If the core is not suspended properly a side pull will be exerted on the lifting hooks sufficient to crack the sand. The clearance between the wall of the core and the wall of the mold is so slight, that unless the core hangs level it will scrape and in extreme cases wreck the wall of the mold coming up and the low edge of the core will crush before it leaves the bottom. Manifestly if the core is not hanging plumb it will not settle properly into its seat when the mold is assembled.

"The hook of the crane is spotted directly over the center of the core and then the four chains are attached to the loops in the core by turnbuckles. The slack of the chain is hoisted and then the turnbuckles are tightened until the core *floats* uniformly at all four corners. The craneman is given the signal to hoist while a man at each corner steadies the core on its way up and prevents it from striking the walls of the mold.



WHY SHOULD THE SPIRIT OF MORTAL BE PROUD

"Procedure would be simplified greatly if the core could be left hanging from the crane until the time came to return it to the mold, but unfortunately this seldom is possible. Usually the service of the crane is required elsewhere in the interim and the core must be set down on the core oven car or on a suitable place on the floor.

"Instead of setting the core down haphazard it should be lowered carefully to within a short distance of its destination and then blocks and wedges should be inserted underneath to catch it in the exact position it is suspended from the crane. When the time comes to pick it up again the turnbuckles are adjusted to float it off uniformly. In this manner the molder is assured that the replacement of the core in the mold will be an exact reversal of its movement coming out.

"The four chains of the crane are widely spread at the bottom, but they all terminate at a common point on the crane hook. Therefore it is apparent that unless proper provision is made they will exert a slanting pull on the lifting plate hooks. Several methods are employed to secure a perpendicular pull, depending on the weight and area of the core. In small jobs a length of scantling corresponding to the distance between each pair of chains is inserted a short distance above the core before the chains are pulled up tight. The slant of the chain commences at these spreaders while the part below is maintained upright.

"In other instances a rectangular frame made from the same material and with the four corners corresponding to the position of the four loops is employed. On heavy jobs a beam is suspended from the crane. A pair of chains is adjusted near each end at a point directly over a pair of loops. This takes care of the end pull. A short transverse spreader as previously described prevents the chains from pulling the loops sideways.

"If for any reason chaplets cannot be used the core may be anchored to the bottom. Hook bolts fastened to a foundation plate in the bottom of the pit or to suitable binders placed in the pit before the pattern is lowered into place are utilized. These bolts are long enough to extend almost to the top of the core. A length of 4-inch pipe a few inches shorter than the bolt is placed over each of the four narrow slots in the plate to provide a passage for the bolt. After the core is returned to place a bolt is dropped down through each pipe. The toe is hooked under the foundation plate or the binder. A washer is placed over the top of the pipe and a nut is screwed down on the top of the bolt until everything is solid and tight iron to iron. The small opening on top of the bolt then is filled with sand and the surface slicked over flush with the face of the core. This is the most satisfactory method of any and may be applied to a green or a dry core.

How and Why in Brass Founding

By Charles Vickers

Using Aluminum Bronze

We are making castings of aluminum bronze, the alloy being copper 90 *per cent and aluminum* 10 *per cent. In shape, the castings resemble the half of a round bushing* 18 *inches long and* 14½ *inches wide, but the inside is cored with a rectangular core which leaves a metal thickness of* 3½ *inches on the sides and about* 4½ *inches over the top. The weight of the casting is* 350 *pounds and we pour it on end, with a sprue reaching to the bottom of the mold on the cored side, and two gates branching to either side. The casting when machined has holes in it which looks as if it was dross. The metal is all virgin and is melted in three No.* 60 *crucibles, which then are poured into one large crucible which is used as a ladle. We use virgin metal because the casting must be free from holes. Your suggestions will be appreciated.*

As aluminum bronze is a temperamental alloy it has to be humored by the molder more than any other, not even excepting manganese bronze. This humoring must take the form of providing a mold that it will *lie against* which means that on no account must the alloy simmer against the sides of the mold, but lay absolutely quiet. So a mold so free and permeable to gases that the only path they can take is into the sand backing, later to dissipate into the atmosphere must be made. This is absolutely imperative. Another matter is the metal must be flowed, or introduced, or gated, if this term is preferred, in such a manner there will be absolutely no meeting of streams. or any impinging on mold or core bodies and last but by no means least, there must be no dropping of the metal when it once gets into the mold. Outside of all this, it will be a wise move to *degasify* the alloy before pouring it.

The reason for the above precautions is simply that the aluminum acts like soap on the copper; it makes it lather, and the lather forms dross in the mold. So, figure how to pour suds into a mold shaped like the casting, and avoid the formation of dross or lather, and the secret is revealed. Also a casting made on end, of this bronze, will require wonderfully heavy risers unless the body is chilled and then a comparatively small riser in sand will do the trick. We would make this casting horizontally with the core down and part of the bottom of the curved surface exactly like a round bushing. On one end we would locate the sprue cutting gates to either side of the curved ends, but the gates would not enter the casting straight into the end, but they would be cut as a groove into the bottom of the sides thus leaving a lump on the casting after breaking away. Thus, the metal would enter quietly, as the mold would be inclined to pour, with the *gated end lowest.* On the high end, as the mold is tilted, a square riser would be put, which for this casting would be about 3 x 4 inches cross section, thus being not square but rectangular in cross section. Raise the sprue so when the casting is poured there will be 3 inches of metal in the riser. Have the riser 6 inches high at least; 8 inches would be better, and then fill the riser up by dribbling in the metal after the sprue was filled and covered with molding sand with a weight bedded thereon. It is easier to get a sound, clean casting of aluminum bronze in this way, than by trying to make it upright. The use of all new metals is necessary, as no scrap aluminum bronze would be worth considering because of possible impurities.

Castings Leak in Test

We are making bronze sleeves required to withstand 300 *pounds water pressure using virgin metals to the following formula: Copper,* 90.60 *per cent; tin,* 5 *per cent; lead,* 2 *per cent; zinc,* 2 *per cent; nickel,* 0.15 *per cent, and iron* 0.15 *per cent. We first melt the alloy and run into ingots then melt the ingots for the castings. We send a sample cut from one of the castings one side of which shows the fracture of the alloy. You will note that the casting shows pit holes and our difficulty is to overcome this to prevent the casting leaking when tested. In the ingot itself the metal is perfectly sound and it only appears when the ingot is remelted and poured into castings which is done at a temperature of* 2100 *degrees Fahr. The castings have a wall* 1½ *inches thick and weigh* 150 *pounds each.*

The metal is not oxidized, it is simply gassed and possibly this condition is caused by melting in an oil or gas-fired furnace and using a reducing flame. If that is the case it will help materially if someone turns off the oil supply valve a little, or turns on the air supply a trifle more. If the condition illustrated by the sample was produced in a crucible in a solid fuel fired furnace, then we are unable to state what has been done to get it that way. We can produce the same result adding sulphur and copper oxide, but the holes will not be so bright which indicates we would not produce the same gas to do the aerating. It is possible to get the same gases by anchoring a piece of graphitic carbon down in the crucible then adding copper oxide which would give us the carbon gases and so produce gassed metal.

As far as the alloy is concerned it is not a good one as it is unnecessarily expensive. Thus the zinc could be increased to 6 per cent with advantage and at the same time a deoxidizer could be added, provided the melting is done in an oxidizing atmosphere. Much greater changes could be made in the alloy but we hesitate to make such suggestions in the absence of specific information about the service it is put to. The condition of the ingot metal before melting for castings means nothing. It would not have been free of porosity in all probability if poured into sand molds and slowly cooled instead of being poured into quick setting ingot molds. The metal probably was gassed on both melts, and would have produced better castings on the first melt.

Uses Silicon Alloy

We are making an ornamental andiron for service in electric fireplaces and use aluminum alloy. The foot of andiron is heavy and the body section light. Can you suggest an alloy suitable for such a casting? We would like it to be sufficiently fluid to run the light section and at the same time avoid shrinkage in the heavy feet.

An alloy of aluminum, 90 per cent; copper, 8 per cent, and silicon 2 per cent will be found satisfactory for this andiron casting.

Materials Handling Engineers *CONSIDER FOUNDRY WORK*

System Developed for Handling Small Castings Speeds Up Work—Suggests Unit Containers for Less Than Carload Lots of Freight

ON APRIL 23 and 24 the first meeting of the materials handling division of the American Society of Mechanical Engineers was held in Philadelphia. More than 200 engineers and guests were present at the technical sessions which took place. The first annual banquet was held Monday evening April 23, with J. G. Hatman, chairman of the Philadelphia section, acting as toastmaster. C. D. Young, general purchasing agent, Pennsylvania railroad and Edward J. Mehren, vice president, McGraw-Hill Co., New York, spoke at the dinner.

Mr. Young stated that material handling problems from the manufacturer's viewpoint will be simplified greatly if he will specify delivery date when purchasing raw materials, and will order quantities just sufficient to cover current needs. The present tendency is to shift the burden of storage to someone else, and since railroad transportation is reliable, the freight car enroute makes an excellent storage medium.

A manufacturer who uses a carload of molding sand every day or every two or three days is able to specify delivery of a carload every day or every two or three days as required, and to have this delivery date met by the supply house with remarkable accuracy. The material then may be dumped into active working hoppers without going to storage.

Mr. Mehren said that the formation of this new materials handling division represented a long step forward in this field which is an essential part of all manufacturing. Advancement in the development of labor-saving devices for production and in the increasing strength and usefulness of materials and in the ingenuity of design have progressed more rapidly than have improvements in materials handling methods according to Mr. Mehren. He then described in detail manufacturing conditions in Germany.

The first technical session of the meeting was devoted to some problems in materials handling in foundries. F. D. Campbell, chief engineer, Eastern Steel Castings Co., Newark, N. J., described in considerable detail, the methods of handling materials at his plant. This foundry produces electric steel castings of light section and in a wide variety of form and quantity. From this fact Mr. Campbell concludes that nearly all so-called jobbing foundries in the country can adopt methods similar to those in use at the Eastern Steel Castings Co. The first task of improving conditions at this plant was to rearrange all manufacturing operations to a straight line flow. Another was to reduce hand labor to the minimum point, and to reduce supervision by a proper order in movement. To meet the large variety of work turned out, the system must be flexible and the system was designed to meet this need.

In brief, all molding sand is conditioned fully before being distributed. It is carried by an overhead belt conveying system around three sides of the molding sections, and automatically is unloaded into hoppers directly above the molding machines. A single shakeout at the molding section dumps the used sand on a belt conveyor which elevates the sand to a vibrating screen which separates the lumps and refuse. Magnetic removal of iron and tempering also is done on this belt which elevates the sand.

Molds are carried on roller conveyor systems and the molds are poured while on the conveyors. Pouring is done from a double-rail overhead system which radiates from a central bull ladle location. From the shakeout another roller conveyor system transports the castings to the cleaning room. Inspection stations placed at various points in the line allow defective castings to be removed before further operations are performed.

H. A. Hoffer, eastern sales manager, United States Cast Iron Pipe & Foundry Co., Philadelphia, presented a paper entitled, "Materials Handling Features of the DeLavaud Process of Casting Pipe Centrifugally." Mr. Hoffer described both the older system of making cast pipe in sand molds and the centrifugal process. In the Burlington, N. J., plant of his company materials handling is done mechanically. Pig iron, coke and limestone are delivered in bulk by rail or barge. Electromagnets are used to remove the iron from the holds of the barges. Three 5-ton travelling cranes extend over the storage yard and cupola decks; each pair of cupolas being served by one crane. Coke is delivered in bottom dumping gondola cars which are carried on a trestle over the bins. Specially constructed boxes are used to carry the materials to the cupolas. Pipe made by the centrifugal process are cast in revolving, steel, cylindrical molds. Metal is poured from a tilting ladle at a predetermined rate through a cantilever trough extending through to the end of the mold. A longitudinal motion of the mold allows the metal to be delivered to the interior of the revolving mold.

After the pipe is cast it is removed by a toggle-joint clamp. Overhead cranes carry the pipe to the rails in front of the annealing ovens. Passage of the pipe through the ovens is timed by the rollers over which they pass. After leaving the annealing ovens the hot pipes are rolled by gravity down skids into the cleaning, coating and testing sheds.

G. C. Woodruff, assistant freight traffic manager, New York Central railroad then described the use of unit containers for the shipment of less than carload lots. These containers usually are made of steel and fitted with tight doors and are leak-proof. Each container handles a maximum load of 8500 pounds of miscellaneous freight and it is intended that these be loaded and locked at the shipper's plant and be unlocked on receipt at the consignee's plant.

The McCann-Harrison Corp., Cleveland, manufacturer of air heaters, furnaces, ovens and dryers, has entered into a co-operative selling agreement with the Nichols Products Corp., 33 West 42nd St., New York, manufacturer of high temperature baking and drying equipment and the Clarage Fan Co., Kalamazoo, Mich., manufacturer of equipment for heating buildings.

Metals and Melting

How Metallurgical Problems Have Been Solved in Gray Iron, Malleable and Steel

Rustproofing Castings

Question: Will you please give us some information on how to make such castings as washboilers, pots and scullery basins rustproof?

Answer: Two types of coatings commonly are used to prevent iron rusting. One type is coating the iron with a metal, generally zinc or tin and the other is the use of a nonmetallic coating such as the magnetic oxide of iron.

The zinc coating is applied to the metal by several different methods or processes—The hot dip process; sherardizing; electrolytic process and the spraying or Schoop process.

Hot dip galvanizing essentially consists in immersing the casting in molten zinc. The castings are sand blasted, pickled in alkaline solutions to remove any grease, washed with hot water and then pickled in an acid solution to remove any sand, oxide or other surface impurities. After washing with hot water the castings are immersed in the bath of molten zinc. The temperature of the bath is about 840 degrees Fahr., and the bath is protected by a cover flux of ammonium chloride. Coating the casting with tin is a similar process.

Sherardizing is applied by placing the castings in a steel or iron drum and adding metallic zinc dust. The drum is placed in a furnace and slowly rotated. The temperatures employed are a trifle slower than those used in the hot dip process.

Electrolytic or zinc plating process is carried on similar to other electro-deposition methods, using zinc anodes.

The Schoop or spraying process employs a pistol shaped device into which oxygen, hydrogen and compressed air are admitted. The oxygen and hydrogen burn inside the pistol and furnish the melting medium. The metal used for spraying is fed into the pistol in wire or thin ribbon form.

Oxide or nonmetallic coatings are applied to iron by the combined use of heat, steam and producer or hydrocarbon gas or by the use of hot solutions of phosphates. Probably, the best known of these methods are the Bower-Barff and the Parker processes. There are others that are modifications of these two methods.

The Bower-Barff process consists of heating the iron to 900 degrees Cent. in closed retorts into which superheated steam is conducted for 20 minutes. The superheated steam then is cut off and replaced by producer gas. This is repeated until the coating is sufficiently thick. This coating is gray and changed to black by immersing in paraffin oil or balsam and linseed oil.

The Parker process of rustproofing employs a hot solution of iron phosphate containing manganese dioxide into which the article is dipped until the coating is thick enough. The color of the coating is dark gray and changes to black when dipped in paraffin or other oil.

We believe that the hot dip galvanizing or tinning process would be the most suitable for the rustproofing of the castings that you have. The coating of zinc adheres strongly and wears well as does tin.

Chills the Iron

Question—I am operating a foundry that requires some hard castings and quantities of soft castings. Sleigh shoes, as an example, should be hard and for this purpose chills are used but they do not chill more than ¼ to ½-inch, whereas they should chill through. I have tried using sulphur in the ladle without results. I would like something I can put in the ladle just before pouring the mold. As only a small part of the heat is for sleigh shoes, I do not want to use steel scrap in the mixture.

Answer—For your purpose the best thing we can suggest is to add ferrochromium in the ladle. Ferrochomium additions will give an extremely hard iron, and should have no trouble with chilling. Even if it should not chill all the way through, which we doubt, you will find that this iron will wear much better than ordinary white or chilled cast iron.

The ferrochromium should be about 8 to 12 mesh, 70 per cent, high carbon, grade. Add about 12 ounces per hundred pounds of metal. The ferrochromium should be placed in a paper bag; some iron (HOT as possible) should be run in to cover the bottom of the ladle a few inches, then the bag is dropped in and the remainder of the iron run in. Stir well and pour into your chill molds.

Castings Become Hard

Question: Will you kindly give us the proper analysis for light machinable castings (vises)? Also can hard castings made from all scrap be softened enough for machining?

Answer: Vises must be made of an iron that may be machined, but at the same time because of hard usage and abuse, the iron must be tough. We suggest the following analyses:

	Light	Medium	Heavy
	Per Cent		
Silicon	2.25	1.75	1.25
Manganese	0.60	0.80	1.00
Sulphur	0.07	0.08	0.09
Phosphorus	0.50	0.40	0.30
Total Carbon	3.25	3.00	2.85

To hold the carbons low, about 10 to 15 per cent steel may be used in the charge.

You might try annealing the hard castings at 700 to 800 degrees Fahr. to obtain better machining qualities. A complete cycle of heat treating would take about seven hours; allowing two or three hours for the castings to reach the proper temperature, holding at this temperature for two hours and then cooling *slowly* for two or three hours in the furnace. Sudden cooling will chill or reharden the castings.

Metal for Shaking Grates

Question—Can you give us any information relative to the analysis of gray iron castings for shaking grates and stokers to withstand high temperatures in high pressure steam boilers?

Answer—One analysis that is recommended for furnace parts that have to resist high temperatures is given as: Total carbon, 2.80 per cent; silicon, 1.10 per cent; phosphorus, under 0.20 per cent; manganese, 0.60 per cent; sulphur, under 0.10 per cent; nickel, 0.95 per cent, and chromium, 0.50 per cent. Another analysis for the same purpose is: Total carbon, low; silicon, 1.25 to 2.50 per cent; sulphur, under 0.10 per cent; phosphorus, under 0.20 per cent; manganese, 0.60 to 1.00 per cent. A third analysis used for grate bars is: Total carbon, low; silicon, 1.25 to 1.75 per cent; sulphur, low; phosphorus, 0.20 per cent; manganese, 0.60 to 0.80 per cent.

The FOUNDRY Family Photograph Album

Upper Left

HARRY W. TITGEN

Titgen-Eastwood Co., Philadelphia

Lower Left

JAMES MITCHELL

Cleveland Co-Operative Stove Co., Cleveland

Upper Right

ARTHUR SIMONSON

Falk Corp., Milwaukee

Lower Right

W. E. SLOAN

Sloan Valve Co., Chicago

CHORD LENGTHS FOR SPACING CIRCLES

By W. L. Tryon

(Continued from Data Sheet No. 716)

No. of Spaces	Length of Chord When Diameter is 1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.
26	1.4464	2.8929	4.3393	5.7858	7.2322	8.6785	10.1250	11.5714	13.0179	14.4643
27	1.3931	2.7862	4.1793	5.5725	6.9656	8.3587	9.7518	11.1449	12.5380	13.9311
28	1.3435	2.6871	4.0307	5.3743	6.7179	8.0614	9.4050	10.7486	12.0922	13.4357
29	1.2974	2.5949	3.8923	5.1897	6.4871	7.7846	9.0820	10.3794	11.6768	12.9742
30	1.2543	2.5087	3.7630	5.0174	6.2717	7.5260	8.7804	10.0347	11.2891	12.5434
31	1.2140	2.4280	3.6421	4.8561	6.0701	7.2841	8.4981	9.7122	10.9262	12.1402
32	1.1762	2.3524	3.5286	4.7048	5.8810	7.0572	8.2334	9.4096	10.5858	11.7621
33	1.1407	2.2813	3.4220	4.5627	5.7034	6.8440	7.9847	9.1254	10.0660	11.4067
34	1.1072	2.2144	3.3217	4.4289	5.5361	6.6433	7.7505	8.8578	9.9650	11.0722
35	1.0757	2.1513	3.2270	4.3027	5.3784	6.4540	7.5297	8.6054	9.6810	10.7567
36	1.0459	2.0917	3.1376	4.1835	5.2293	6.2752	7.3211	8.3669	9.4128	10.4587
37	1.0177	2.0353	3.0530	4.0707	5.0883	6.1060	7.1237	8.1414	9.1590	10.1767
38	.9910	1.9819	2.9729	3.9638	4.9548	5.9457	6.9367	7.9276	8.9186	9.9095
39	.9656	1.9312	2.8968	3.8624	4.8280	5.7936	6.7592	7.7248	8.6904	9.6560
40	.9415	1.8830	2.8245	3.7660	4.7075	5.6491	6.5906	7.5321	8.4736	9.4151
41	.9186	1.8372	2.7558	3.6744	4.5930	5.5115	6.4301	7.3487	8.2673	9.1859

No. of Spaces	Length of Chord When Diameter is 1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.
26	.1205	.2411	.3616	.4821	.6027	.7232	.8438	.9643	1.0848	1.2054	1.3259
27	.1161	.2322	.3483	.4644	.5805	.6966	.8127	.9287	1.0448	1.1609	1.2770
28	.1120	.2239	.3359	.4480	.5598	.6718	.7838	.8957	1.0077	1.1196	1.2316
29	.1081	.2162	.3244	.4324	.5406	.6487	.7568	.8650	.9731	1.0812	1.1893
30	.1045	.2091	.3136	.4181	.5226	.6272	.7317	.8362	.9408	1.0453	1.1498
31	.1012	.2023	.3035	.4047	.5058	.6070	.7082	.8093	.9105	1.0117	1.1129
32	.0980	.1960	.2941	.3921	.4901	.5881	.6861	.7841	.8822	.9802	1.0782
33	.0951	.1901	.2852	.3802	.4753	.5703	.6654	.7604	.8555	.9506	1.0456
34	.0923	.1845	.2768	.3691	.4613	.5536	.6459	.7381	.8304	.9227	1.0150
35	.0896	.1793	.2689	.3586	.4482	.5378	.6275	.7171	.8068	.8964	.9860
36	.0872	.1743	.2615	.3486	.4358	.5229	.6101	.6972	.7844	.8716	.9587
37	.0848	.1696	.2544	.3392	.4240	.5088	.5936	.6784	.7633	.8481	.9329
38	.0826	.1651	.2477	.3303	.4129	.4955	.5781	.6606	.7432	.8258	.9084
39	.0805	.1609	.2414	.3219	.4023	.4828	.5633	.6437	.7242	.8047	.8851
40	.0785	.1569	.2354	.3138	.3923	.4708	.5492	.6277	.7061	.7846	.8631
41	.0765	.1531	.2296	.3062	.3827	.4593	.5358	.6124	.6889	.7655	.8420

No. of Spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
26	.0151	.0301	.0452	.0603	.0753	.0904	.1055
27	.0144	.0288	.0432	.0575	.0719	.0863	.1007
28	.0140	.0280	.0420	.0560	.0700	.0840	.0980
29	.0135	.0270	.0405	.0541	.0676	.0811	.0946
30	.0131	.0261	.0392	.0523	.0653	.0784	.0915
31	.0126	.0253	.0379	.0506	.0632	.0759	.0885
32	.0123	.0245	.0368	.0490	.0613	.0735	.0858
33	.0119	.0238	.0356	.0475	.0594	.0713	.0832

No. of Spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
34	.0115	.0231	.0346	.0461	.0577	.0692	.0807
35	.0112	.0224	.0336	.0448	.0560	.0672	.0784
36	.0109	.0218	.0327	.0436	.0545	.0654	.0763
37	.0106	.0212	.0318	.0424	.0532	.0636	.0742
38	.0103	.0206	.0310	.0413	.0516	.0619	.0723
39	.0101	.0201	.0302	.0402	.0503	.0603	.0704
40	.0098	.0196	.0294	.0392	.0490	.0588	.0687
41	.0096	.0191	.0287	.0383	.0478	.0574	.0670

(Concluded on Data Sheet No. 722)

CHORD LENGTHS FOR SPACING CIRCLES

(Concluded from Data Sheet No. 721)

No. of Spaces	Length of Chord When Diameter is 1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.
42	.8968	1.7935	2.6903	3.5870	4.4838	5.3806	6.2773	7.1741	8.0709	8.9676
43	.8759	1.7519	2.6278	3.5038	4.3797	5.2557	6.1316	7.0075	7.8835	8.7594
44	.8561	1.7121	2.5682	3.4243	4.2803	5.1364	5.9925	6.8486	7.7046	8.5607
45	.8371	1.6742	2.5112	3.3483	4.1854	5.0225	5.8595	6.6966	7.5337	8.3708
46	.8189	1.6378	2.4567	3.2756	4.0945	4.9134	5.7324	6.5513	7.3702	8.1891
47	.8015	1.6030	2.4045	3.2060	4.0076	4.8031	5.6106	6.4121	7.2136	8.0151
48	.7848	1.5697	2.3545	3.1393	3.9242	4.7090	5.4939	6.2787	7.0635	7.8484
49	.7688	1.5377	2.3065	3.0754	3.8442	4.6131	5.3819	6.1507	6.9196	7.6884
50	.7535	1.5070	2.2605	3.0139	3.7674	4.5209	5.2744	6.0279	6.7814	7.5349
51	.7387	1.4774	2.2162	2.9549	3.6937	4.4324	5.1711	5.9098	6.6486	7.3873
52	.7245	1.4491	2.1736	2.8982	3.6227	4.3472	5.0718	5.7963	6.5209	7.2454
53	.7109	1.4218	2.1327	2.8435	3.5544	4.2653	4.9762	5.6871	6.3980	7.1089
54	.6977	1.3955	2.0932	2.7910	3.4887	4.1864	4.8842	5.5819	6.2796	6.9774
55	.6851	1.3701	2.0552	2.7403	3.4253	4.1104	4.7955	5.4805	6.1656	6.8507
56	.6728	1.3457	2.0185	2.6914	3.3642	4.0731	4.7099	5.3828	6.0556	6.7284
57	.6611	1.3221	1.9382	2.6442	3.3053	3.9663	4.6274	5.2884	5.9495	6.6105

No. of Spaces	Length of Chord When Diameter is 1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.
42	.0747	.1495	.2242	.2989	.3736	.4484	.5231	.5978	.6726	.7473	.8220
43	.0730	.1460	.2190	.2920	.3650	.4380	.5110	.5840	.6570	.7300	.8029
44	.0713	.1427	.2140	.2854	.3567	.4280	.4993	.5707	.6421	.7134	.7847
45	.0698	.1395	.2093	.2790	.3488	.4185	.4883	.5581	.6278	.6976	.7673
46	.0682	.1365	.2047	.2730	.3412	.4095	.4777	.5459	.6142	.6824	.7507
47	.0668	.1336	.2004	.2672	.3340	.4008	.4675	.5343	.6011	.6679	.7347
48	.0654	.1308	.1962	.2616	.3270	.3924	.4578	.5232	.5886	.6540	.7194
49	.0641	.1281	.1922	.2563	.3204	.3844	.4485	.5126	.5766	.6407	.7048
50	.0628	.1256	.1884	.2512	.3140	.3767	.4395	.5023	.5651	.6279	.6907
51	.0616	.1231	.1847	.2462	.3078	.3694	.4309	.4925	.5540	.6156	.6772
52	.0604	.1208	.1811	.2415	.3019	.3623	.4226	.4830	.5434	.6038	.6642
53	.0592	.1184	.1777	.2370	.2962	.3554	.4147	.4739	.5332	.5924	.6516
54	.0581	.1163	.1744	.2326	.2907	.3489	.4070	.4652	.5233	.5814	.6396
55	.0571	.1142	.1713	.2284	.2854	.3425	.3996	.4567	.5138	.5703	.6280
56	.0561	.1121	.1682	.2243	.2804	.3364	.3925	.4486	.5046	.5607	.6168
57	.0551	.1102	.1653	.2204	.2754	.3305	.3856	.4407	.4958	.5509	.6060

No. of Spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
42	.0093	.0187	.0280	.0374	.0467	.0560	.0654
43	.0091	.0182	.0274	.0365	.0456	.0547	.0639
44	.0089	.0178	.0268	.0357	.0446	.0535	.0624
45	.0087	.0174	.0262	.0349	.0436	.0523	.0610
46	.0085	.0171	.0256	.0341	.0427	.0512	.0597
47	.0083	.0167	.0250	.0334	.0417	.0501	.0584
48	.0082	.0164	.0245	.0327	.0409	.0491	.0572
49	.0080	.0160	.0240	.0320	.0400	.0481	.0561

No. of Spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
50	.0078	.0157	.0235	.0314	.0392	.0471	.0549
51	.0077	.0154	.0231	.0308	.0385	.0462	.0539
52	.0075	.0151	.0226	.0302	.0377	.0453	.0528
53	.0074	.0148	.0222	.0296	.0370	.0444	.0518
54	.0073	.0145	.0218	.0291	.0363	.0436	.0509
55	.0071	.0143	.0214	.0285	.0357	.0428	.0500
56	.0070	.0140	.0210	.0280	.0350	.0421	.0491
57	.0069	.0138	.0207	.0275	.0344	.0413	.0482

THE FOUNDRY DATA SHEET, JUNE 15, 1928

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Better Iron Obtained

with Efficient Cupola Operation

By A. J. Meissner

RECENT developments and experiments have proved conclusively that the foundryman of today not only must provide better supervision over the pig iron and scrap that he daily melts in his cupola but also he must provide the utmost care in the construction of his cupola, in the operation of the cupola and in the fuel he uses during the melting process. A great many castings still are going out into the field of service that may cause grief to the foundryman and the customer. Grief to the foundryman because naturally it is up to him to supply a new casting through some form of adjustment and grief to the customer in that only too often it is the direct cause in cutting down his production, an all important part in his manufacturing program.

Loss of production reflects at once in the manufacturer's cost prices, a serious sickness in this age of keen competition. Any foundryman can mention readily almost without number work now made of cast steel, stampings, etc. which formerly were made of cast iron. Why? The answer is obvious. One need only analyze the situation and he will find that while the steel castings industry, the stamping industry, etc., have been ever on the job to get all the business they possibly could, the foundryman has been standing idle and watching the business get away from him. The foundryman is being pushed against the wall and is getting awake. He is becoming aware of the fact that he can still exact a livelihood out of his business but he must be as equally alert as the steel industry.

Performing Experiments

The result is that the old attitude of *Letting George Do It* practically has disappeared and almost every cast iron foundry today is experimenting in some way or other with the ultimate objective of better cast iron. Cupola operation and construction has developed into an important position in this reconstruction program. Like the blast furnace of today the cupola is no longer being classed as just a melting medium. Every foundryman realizes that the best cast iron is obtained when the cupola is operated at maximum melting capacity. This assertion is proved readily by observing the difference between the iron from a cupola that is operated efficiently and one that is run under the old or more inefficient methods. Table I is a good illustration of the physical difference using the same mixture in both cases. The mixture contained 800 pounds, No. 1 broken machinery scrap and 1200 pounds No. 2 X foundry pig iron and gave the following analysis: Silicon, 2.05 per cent; sulphur, 0.09 per cent; phosphorus, 0.435 per cent; manganese, 0.567 per cent; combined carbon, 0.378 per cent, and total carbon 3.79 per cent.

Use 48-inch Cupola

The most remarkable difference between the same iron made in these tests was in the carbon structure. In the iron of the old or usual practice the carbon structure was the usual large flaky nature while that of the improved method was the more desired short round granular structure which denotes strength in cast iron. To appreciate more fully the difference between the two practices it will be necessary to discuss the construction of the cupolas as well as the differences between their operation in detail.

The cupolas used in these tests had the same dimensions and were equipped with the same blowing equipment which made comparison a simple matter. Both cupolas were lined to 48 inches in diameter at the tuyeres with a basin or well deep enough so that a ton of iron could be tapped out at each time. The difference being in the tuyere area, tuyere arrangement, method of air entry into the wind chamber and the method of operating. All charges were made up of 1-ton metal charges with the pig iron and scrap as nearly uniform in size as possible.

In the construction of cupola No. 1, used in old or usual practice, a 60-inch diameter sheel was lined down to 48 inches. It had a single row of tuyeres 24 inches above the bottom doors. Six tuyeres, 4 x 12 inches equally spaced, gave a tuyere ratio of approximately 1 to 6.6. The wind chamber was arranged so that the wind entered at the bottom of the chamber. The windpipe from the blower was placed so that the air entered the chamber as much as possible between the tuyeres. Only one pipe ran from the blower to the wind box.

In making up the cupola for the charge an initial fuel charge of approximately 1300 pounds of coke was placed on a layer of kindling wood sufficient to ignite the coke charge with the aid of the natural draft supplied by the cupola stack. This method of lighting the cupola usually requires about 30 minutes to ignite thoroughly the initial fuel charge or bed. This usually gave a bed when the cupola was ready for the first iron charge from 20 to 25 inches above the tuyeres. In making the iron charge care was taken to charge the pig iron and heavier sections of scrap first into the cupola with the lighter section scrap, such as sprues, etc., charged last. A fuel charge of 250 pounds coke was placed between each iron charge with charging continued until the cupola was filled to the charging floor after which it was allowed to lay quiet for a period of at least 2 hours. This allowed sufficient time to heat each charge thoroughly and invariably gave hot first iron. All charging was done by hand.

Increase Amount of Coke

On close observation we found by checking the air volume against the blast pressure that at 9 ounces blast pressure the blower delivered approximately 3500 cubic feet of air per minute while at 12 ounces blast pressure approximately 4000 cubic feet of air per minute. The best average results were obtained when the blast pressure was maintained as nearly at 9 ounces as possible with the slight reduction in cupola capacity. A notable feature in operating this cupola at the higher blast pressure and consequently greater air volume was the increased danger of oxidized iron. A condition that was readily apparent in the behavior of the iron during pouring.

During the early stages of these tests it became apparent that while

the fuel used gave the best average results, it also was noticed that with an increase of fuel both in the height of the initial fuel charge and a still further increase of fuel between the iron charges, that there was a material benefit to the iron. However, cupola capacity was reduced to such an extent that there was the other danger of having the molten iron too long in the presence of the oxidizing elements. Having another cupola of the same dimensions available it was decided to reconstruct it so that if possible advantage could be taken of the increased fuel conditions and the cupola speeded up to the point where the oxidizing danger could be reduced to a minimum.

Accordingly the tuyere area of this second cupola was increased to a point where reasonable assurance was had that the tuyeres would deliver the necessary increased air volume without increasing the blast pressure. This would assure an easy air flow and at the same time eliminate the danger of an oxidizing flame at the tuyeres. In addition to this the air inlet opening into the wind chamber was changed from one opening to two. These openings were arranged directly opposite each other and gave a more uniform air distribution in the air chamber. The results of the first test run held great promise and the following cupola construction and operating routine finally was developed:

As with cupola No. 1 a 60-inch diameter cupola shell was lined down to 48 inches at the tuyeres. A single row of six tuyeres 5 x 15 inches long equally spaced was built in 24 inches above the cupola bottom, giving a tuyere ratio to the cupola area of 1 to 4. Placing the tuyeres 24 inches above the cupola bottom allowed a 1-ton top to be made at each opening of the cupola. As stated two air inlet pipes gradually merging into one from the blower were placed directly opposite each other to ease the flow of air from the blower. The blower was then speeded up so that it delivered approximately 5000 cubic feet of air per minute at 9 ounces per square inch pressure.

In making up the cupola charge it was found that under the new conditions an initial fuel charge of from 35 to 40 inches above the tuyeres gave good hot, first-iron in about 15 minutes after blast was put on the cupola. We also found that by removing the tuyere covers on the wind box that with natural draft the cupola was ready for the first iron charge in about 45 minutes. As in cupola No. 1 iron charges of 1-ton each were charged while the fuel charges between each iron charge was increased from 250 pounds to 300 pounds giving a fuel ratio between charges of approximately 1 to 6.6. This was done to provide fuel carbon for the additional air available. The result of this step was that even the first tap iron came from the cupola extremely hot with good life in the iron during pouring. Another remarkable feature was the fact that the melting zone was not raised to any unreasonable extent. Another feature was that while the iron was extremely hot the oxidation losses were low.

In a number of test runs made for comparison purposes not only was the method described for cupola No. 2 beneficial to the iron when making ordinary gray iron but the same condition held true when melting semi-steel.

Table I

Compares Results Obtained

Old Test No.	Transverse	Practice Tensile	New Test No.	Transverse	Practice Tensile
1	2,045	19,875	1	2,455	21,345
2	1,970	18,760	2	2,385	22,500
3	2,185	20,530	3	2,560	21,785
4	2,075	18,655	4	2,415	22,320
5	1,990	19,125	5	2,530	22,750

Materials Are Satisfactory

Question: Occasionally in American shop pictures published in THE FOUNDRY I note instances where a trail of paste or a dough worm is used either to prevent a runout or to form a tight connection between cores. Also reference is made to pasting half cores together. I use molasses and flour on this side (England) but it dries so rapidly that I only can mix small quantities at a time. I should like to know what material is used in American foundries and whether it may be thinned with water when necessary.

Answer: Practice in individual shops varies to some extent, but in the main American foundry practice does not differ from that of England. Flour is mixed with plain water either for paste or for dough worms. The worms of course dry rapidly and are prepared only in a sufficient quantity for the job in hand. Paste is mixed like claywash in a pot or bucket and under ordinary conditions lasts indefinitely. The pot never is cleaned out, but as the supply diminishes, more water and flour are added. In recent years a ready made liquid paste has been available. It is on sale by the foundry supply houses and is used extensively, particularly in the specialty shops on mass production. It is applied through a small pipe nozzle attached to a rubber bulb.

Methods adopted on large molds and cores naturally differ to some extent from those employed on small jobs. Also many small adjustments required on a mold the first time it is assembled may be omitted on subsequent occasions. The most commonly used material to insure a *touch* between adjoining parts of a mold or core is parting sand applied either on the plain surface or behind a light furrow scratched with the point of the trowel. Worms are made from flour and water, clay, putty, and loam. Blacking mixed with oil sometimes is used. In some instances the joints between adjoining molds and cores are daubed with sand or loam and slicked over. In other instances this is omitted on the ground that it is cheaper to chip the fins.

Will Have Exhibition

Preparations are advanced well in connection with the international foundry trades exhibition, which will be held in London, England, from June 5 to 15, 1929, to synchronize with the International Foundrymen's congress. Support is being accorded to the exhibition by leading manufacturers in Great Britain and Germany, and French, Belgian, American, and other overseas firms also have taken important spaces. Everything is being done to insure that delegates and visitors to the international convention will have the opportunity of studying the display of foundry equipment and supplies many of which will be demonstrated under working conditions. The Foundry Trades' Equipment & Supplies association and the Institute of British Foundrymen both accord their patronage and active support to the exhibition, full particulars of which may be obtained from the organizers, F. W. Bridges & Sons, Ltd., Avenue Chambers, 4, Vernon Place, Southampton Row, London, W. C. 2.

Roundhouse Plan Utilizes Limited Space Economically

FIG. 1—CIRCULAR FOUNDRY 265 FEET IN DIAMETER IS CONNECTED TO THE HARBOR ON ONE SIDE BY A CANAL WHICH EXTENDS INTO THE SHOP FOR OVER 60 FEET. LOCOMOTIVE CRANES ON A CIRCULAR OUTSIDE TRACK HANDLE FLASKS AND OTHER MATERIALS INCLUDING THE CHARGES FOR THE CUPOLAS

Danish Firm Adopts Novel Idea

In Foundry Construction

By Vincent Delport

(European Manager, THE FOUNDRY)

IN A maritime nation like Denmark it is only natural to find that shipbuilding is and always has been practiced extensively. According to accepted tradition the Vikings patronized the various galley lines by which they paid friendly visits, and some that were not quite so friendly, to all the lands bordering on the North sea. Claim is made that they visited Iceland and some parts of the North American continent. Certainly the original of Longfellow's *Skeleton in Armor* did not come across the western ocean in an air ship.

Descendants of the Vikings and those who built their galleys turned their hands later to commercial pursuits and since Denmark practically is an island, the building and sailing of ships followed as the night the day. In the eighteenth and nineteenth centuries wood vessels of all descriptions from the little fishing boat to the stately full rigged ship, were built for home and foreign customers. These ships have plyed the seven seas and have made known throughout the world the skill of Danish shipbuilders.

FIG. 2—CAST STEEL CRANK WEBS ARE GIVEN A DROP TEST

Steel gradually took the place of wood in hull construction and steam gradually displaced mast and sail. The steam engine passed through several forms, culminating in the turbine. Now it too is losing its grip to a considerable extent in the marine field in favor of the diesel internal combustion oil engine. Danish shipyards and Danish engine builders have adapted themselves readily to the various changes and have kept their shops and manufacturing equipment and methods fully abreast of the times.

A new foundry erected by Burmeister & Wain, Copenhagen, and placed in service a few years ago represents the latest development in practice connected with a highly specialized product. Building construction and equipment show a radical departure in many respects from these features as seen elsewhere. The building is circular instead of the conventional rectangu-

lar shape and the traveling cranes are pivoted at various heights from a central steel mast to enable any one of the six to make a complete circuit of the foundry. A general exterior view of this highly interesting and unique foundry is shown in the accompanying illustration Fig. 1, while a partial view of the interior is shown in Fig. 4.

Concrete and steel were used in the construction of the building. Light is admitted through large windows in the walls and through a series of wide skylights in the curving roof. The center of the roof terminates in a cupola enclosed in a continuous ventilator screen.

For many years the company operated a foundry at Christianshavn an outlying suburb of the city to the north. When necessity for expansion suggested the propriety of erecting an entirely new shop a site was selected at Teglholmen at the edge of the harbor. A canal or water passage extends into the foundry and materials of various kinds may be loaded or unloaded directly by the foundry cranes. Finished castings are taken in barges to their destination and foundry supplies are brought in from various points by the same medium.

Decision to build and equip a circular shop was reached after due deliberation in which the advantages of this type of construction and layout were compared with those in the style and shape of building which has come to be regarded as standard. After several years experience it is claimed that the circular shop has measured up to expectations. Crane service is greatly faciliated and this in turn is reflected in the rapid movement of all kinds of material including sand and iron. The building and most of the equipment were designed by the company's own engineering staff, fabricated in its own shops and erected by its own workmen.

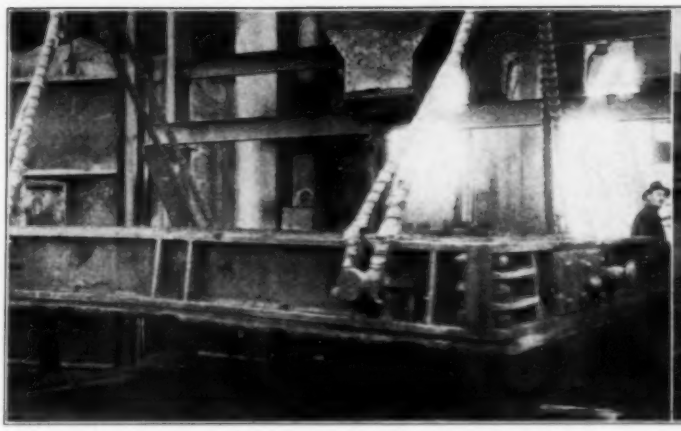
FIG. 3—MOLD IS ROLLED OVER AFTER IT HAS BEEN JOLTED ON A MACHINE

General view in plan and section of the foundry is shown in Fig. 7. The cupolas occupy a position at the left center and directly opposite the canal which leads to the harbor. The charging floor extends beyond the building as may be noted in the illustrations Figs. 1 and 6. Materials for the charge are lifted and placed thereon by the locomotive type yard crane shown in the same illustration. This crane also is utilized for handling the flasks in the yard which surrounds the foundry. Loads are carried into and out of the shop on two short lengths of narrow gage track shown to the right and left respectively a short distance above the center line in Fig. 7.

Location of the core and mold drying ovens is shown in Figs. 4 and 7. They are situated between columns which support the gallery and extend into both the center and the side bay. The double tracks extend beyond the oven at each end so that molds and cores may be loaded and unloaded either in one bay or in the other.

Heap sand, facing sand and core

FIG. 4—THE MAIN BAY OF THE FOUNDRY IS SERVED BY THREE 30-TON AND THREE 10-TON CRANES ALL PIVOTED FROM A CENTRAL STEEL COLUMN AND ARRANGED AT DIFFERENT HEIGHTS TO SWING CLEAR OF EACH OTHER



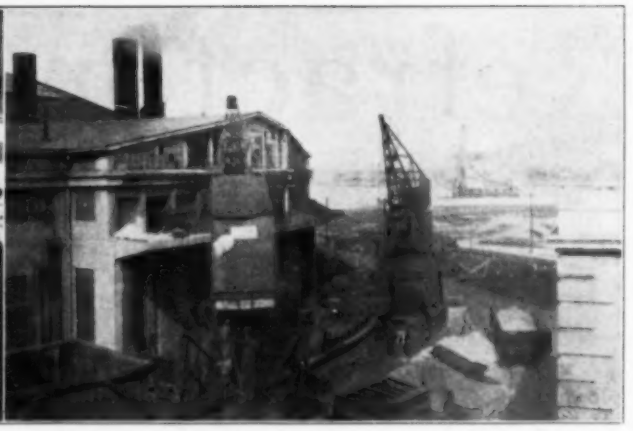


FIG. 5—ONE OF THE PLAIN JOLT MACHINES LOCATED UNDER A SAND HOPPER IS CAPABLE OF JOLTING AN 18-TON MOLD. FIG. 6—THE CUPOLA CHARGING PLATFORM EXTENDS OUTSIDE THE BUILDING

sand are prepared in a mechanical sand handling plant located on the gallery and afterward are distributed on a light electrically operated railroad to any required point in the foundry. Part of this equipment is shown in the back center Fig. 4.

General Layout

The center of the building is occupied, by a 2-story reinforced concrete and steel structure 60 feet in diameter which houses the office, store department, canteen and sanitary stations. A great deal of attention is paid in this plant to the material comfort and well being of the employes.

A steel mast anchored solidly in concrete at the bottom and braced on all sides by the roof beams at the top, serves as a pivot for six electric traveling cranes, mounted one above the other so that if necessary any one crane may make a complete circuit. The main hoist on three cranes has a lifting capacity of 30 tons with an auxiliary hoist of 3 tons. Each of the other three cranes has a lifting capacity of 10 tons.

These cranes serve the main bay of the foundry 70 feet in width, extending as may be noted in Fig. 2 from the central building to the row of columns which supports the gallery and the outer runways for the three heavy cranes. The bridges of the 10-ton cranes travel on a rail located on the upper perimeter of the central building. The outer end is unsupported.

All the large castings are molded in the main bay either in pits in the floor or in large iron flasks. Molding practice is similar to that practiced elsewhere in European and American foundries specializing in the manufacture of heavy machinery and engine castings. Many of the large core and mold part are made on jolt machines. The largest machine has a lifting and jolting capacity of 18 tons. Most of the molding machines are operated with hydraulic instead of pneumatic power. This feature is found commonly in most European foundry installations.

Cores and medium weight castings are made in that circular section of the foundry located between the row of columns and the wall of the building. Light castings are molded and poured on a gallery above the outer floor and extending entirely around the interior of the building. Entrance to the gallery is by two wide stairways on the exterior, one of which is shown a little to the left of the center in the illustration Fig. 1. The molding space under the gallery is

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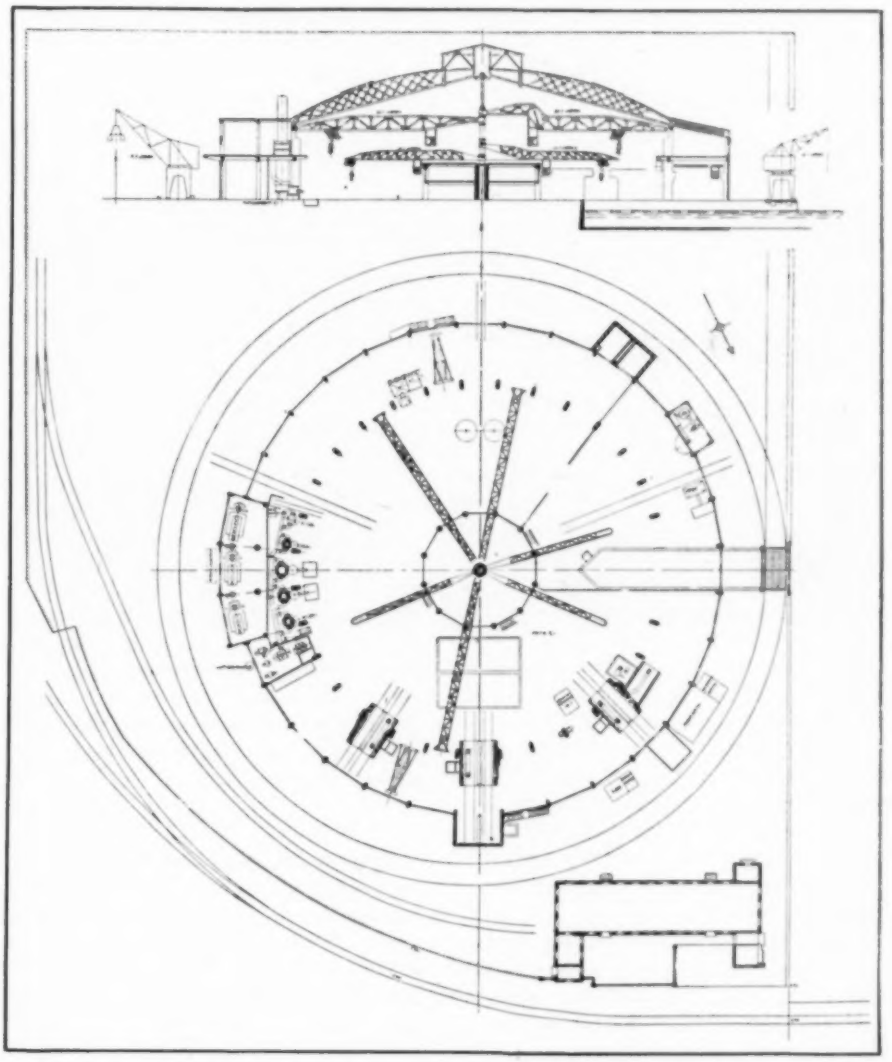


FIG. 7—GENERAL PLAN OF THE CIRCULAR FOUNDRY SHOWING THE LOCATION OF THE CRANES, OVENS, CUPOLAS, PITS, JOLT MACHINES, SAND HANDLING EQUIPMENT AND CANAL

Refractories Industry

Makes Rapid Progress

By J. D. Ramsay

THE refractories industry is engaged in the manufacture and distribution of materials that will withstand conditions where high temperatures are present. It is one of the most important basic industries. Practically nothing can be produced without the use of refractories, directly or indirectly. They are used directly in the manufacture of steel, glass, brass, chemicals, etc., and indirectly in the production of electricity, gas, wearing apparel and household supplies. In fact, nearly all commodities are dependent upon refractories to some extent.

It is rumored that the industry was born in 1812. Records indicate that it originated along the Raritan river in New Jersey in 1825. It grew and spread through that state to a considerable extent. Later a member of the family established itself in the lumber camps along the Susquehanna river in Pennsylvania about 1836. That family spread throughout Western Pennyslvania and today some five or six counties in that section produce probably two-thirds of all the refractories made in the United States.

Settles in Maryland

Another member of the family established a settlement in Maryland, about 1837. The movement continued westward, and a settlement was established at Wellsville, O., in 1846. That same year members of the family moved to Missouri, prospered, and increased so rapidly that it is today the second largest producing district in the United States. In about 1870 the family that established itself in Kentucky prospered so much that it is now the fourth largest producing district. About the same year another settlement was made in Ohio, in the vicinity of Canton, and that, too has grown and flourished to a marked degree.

Little record exists of the annual production prior to 1870, but indications are that the growth was slow up to that time. Total production in 1870 was something like 60,000,000. In 1880, it was a little over 163,000,000 and in 1890, it had jumped to 391,000,000. In 1899, it had reached 800,000,000 and in 1909, 838,000,000. In 1919, production was 1,174,000,000; while in 1926 the records indicate a production of approximately 1,300,000,000. This shows that it doubled its capacity each 10 years until 1919, when the gain over 1909 was about 50 per cent. According to the best information available, the refractories industry has spread to 19 states, tabulated according to their present production: Pennsylvania, Missouri, Ohio, Kentucky, Illinois, Maryland, California, New Jersey, Colorado, New York, Washington, West Virginia, Georgia, Connecticut, Alabama, Texas, Indiana, Utah, Montana.

This article is abstracted from a paper presented at the joint meeting of the American Institute of Chemical Engineers and the American Refractories institute which was held at St. Louis during the winter. The author is president of the Elk Fire Brick Co., St. Marys, Pa.

Development of scientific distribution has not kept pace with the increase in production. Up to 1870 most of the brick were traded. For instance, the manufacturer would trade his refractories for such supplies as iron, nails and shovels, which he in turn sold through supply stores to his employes and townsfolk. The next period developed selling methods, but even then practically no scientific study of the products and service was made. It will be noted that the production jumped from 153,000,000 to 323,000,000 during this period.

Production Increases Rapidly

The period from 1890 to 1910 was a good fellowship period. Production increased so rapidly that in the 20 years it doubled itself. During the great steel boom from 1898 to 1907, unheard-of quantities of fire brick were required for the building of coke ovens and blast furnaces. Great steel plants were built, the capacities of the fire brick plants were taxed to their utmost, and the byword was production rather than development.

The next period, from 1910 to 1920, was a real awakening period. The producer and consumer alike felt the need of research for better products, or a more thorough knowledge of refractories and their limitations. Production increased from 850,000,000 to more than 1,200,000,000. It was a highly competitive period, especially until 1915. The World war retarded this research progress, however, for from 1915 to 1920 production and more production was the watchword. New plants were built, face brick plants were converted into fire brick plants, and every facility used to get increased output. As a consequence, research was again set back, this time due to the great demand brought about by the war. However, a research laboratory was established by the bureau of standards in 1910 and the equipment of similar laboratories followed. In 1917 the Refractories Manufacturers' association established one. Had it not been for the interference of the war, this last period would have developed greatly along research lines. As it is, only a start was made, leading into the period of research in 1920.

Desire Better Refractories

The call for greater production ceased and in its stead came a new one, namely, better refractories. The war and, incidentally, the income tax laws, brought to industry better bookkeeping, more complete accounting systems, the consideration of depletion, depreciation, obsolescence, and last, but not least, a cost system. The latter began to point its fingers to high costs of operation. Among other things it pointed to refractories and their service. That in turn forced tests, trials and research in the individual plant where refractories were used. It brought specifications, criticisms and technical discussions, while at the same time the producer began to realize the necessity of better products and a more thorough knowledge of his material and its uses. He became awakened thoroughly to the importance of his industry and the necessity for making a better product.

Today all this is being accomplished

through organization and co-operation. The consumer and the producer now realize that their interests are not inimical, but one and the same. They know it is necessary to have the best co-operation possible; for the consumer to know what he is buying and what he is buying it for; for the producer to know what he is selling and what it is to be used for. The result is better refractories today than there were yesterday—much better refractories in 1927 than in 1921. Proof of this lies in the small increase in production in 1926 over 1920, notwithstanding the tremendous increase in the industries in which the material is used.

Now that the consumer's interest has been stimulated, the result is that technical men in a large measure have been given control of refractory problems. This makes possible a better correlation of properties of refractories and application to service, and on the part of the consumer, a better understanding of the limits and properties of refractory materials.

Study Service Conditions

It would be difficult to estimate the value derived through technology. In years past the handicaps of the research man did not enable him to obtain the factors or conditions which determine the life of refractories in service. Recent studies of service conditions through the co-operation of the consumer supply fundamental information which is having a marked influence on the nature of research work. This information is enabling them to design and develop tests which will actually supply information regarding the behavior of refractories in certain types of service. Testing in the past has not supplied authoritative information in this direction, and, therefore, has not been made use of to its fullest extent. It is only through the insight of the actual behavior of refractories in service that products can be materially improved.

In the author's opinion, a tremendous economic loss results in the failure of the producer and the consumer to work closer together. The price of the brick ought to be a secondary consideration; the object should be to get longer life out of every lining than the one previous. Every reliable producer in this business is exceedingly anxious to get a superior product and to furnish something which will last longer. Likewise, every consumer keenly is interested in getting a superior product. He is not so much interested in what it costs as in how long it will last. The consumer understands his requirements and service conditions better than any producer, while the producer understands his own product, its limitations and its possibilities, better than any consumer.

It is entirely obvious that if these two get together and exchange information the net result will be better refractories and longer service. It is a lamentable fact that the producer or his representative frequently is prohibited from seeing the engineer or superintendent of the plant where his product is being used to get first hand information on service conditions. The reverse is true, in that these operators are not able to get in touch with the producer. This is a barrier which should be removed, and so long as it exists any effort to improve the product will be retarded.

Information obtained through co-operation with the consumer will be of great value in the outlining of research problems. There are a number of laboratories especially equipped for research in the field of refractories whose work in the past has been of great value, but whose future progress will be largely affected by the relation between the user and producer. The equipment is available and there is a willingness to proceed. With closer co-ordination and a wholehearted purpose, there is no limit to future progress.

Foundry Wins Award

THE foundry department of the Packard Motor Car Co., Detroit, recently won the prize for cleanliness in that plant. The accompanying illustration shows Alvan Macauley, president of the Packard company, presenting the banner to R. M. Scott, manager of the Packard foundry. Mr. Macauley is at the left and Mr. Scott is on the right. E. F. Roberts, vice president of manufacturing, is shown standing in the rear. Mr. Macauley also presented each employe of the foundry with a $5 gold piece as a reward for the individual part played in securing the award.

Danish Firm Adopts Novel Idea

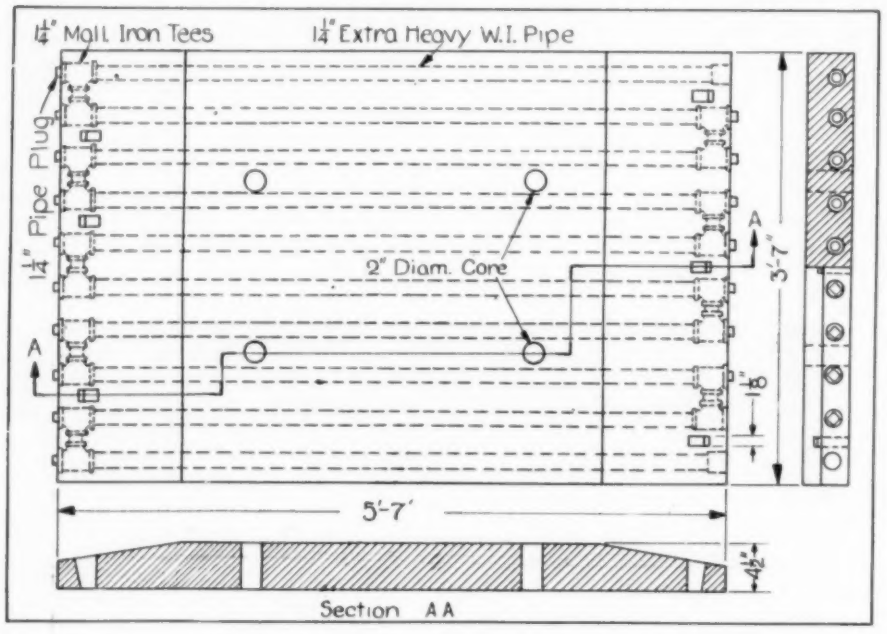
(*Concluded from Page* 499)

served by four electric traveling cranes, each with a lifting capacity of 6 tons.

Castings are cleaned on a section of the main floor set aside for the purpose in the vicinity of the canal. Slag from the cupolas and refuse of all kinds are loaded on barges and later dumped in the deep water of the harbor. Annual capacity of the foundry is approximately 20,000 tons from a floor space of 74,471 square feet, exclusive of the building in the center, but including the gallery. Based on an average output of 66 tons per day over a yearly period of 300 working days, the tonnage per square feet of floor space works out at 1130 square feet per ton.

Pipe Coils Leak in Iron Furnace Bottom

Question: We have experienced considerable trouble in attempting to make the furnace bottom plate with a coil shown in the accompanying illustration. The pipe is 1¼-inch extra heavy with the ends connected by malleable iron tees. The outlets are stopped with standard plugs. It is claimed the openings in the ends are required for future cleaning of the pipe. The pipe joints are coated with graphite grease before the connections are screwed firmly into place.



EXPANSION AND SUBSEQUENT CONTRACTION LOOSENS THE MALLEABLE IRON CONNECTIONS ON THE ENDS OF THE STRAIGHT PIPE SECTIONS AND CAUSES THEM TO LEAK

The casting is made in a dry sand mold and gated at one side about 10 inches from each end. The casting is poured from a half and half pig iron and scrap mixture which yields a 1.80 per cent silicon content in the casting. The metal is poured hot and a stream of water is kept flowing through the coils while the mold is filling. We have made a number of these castings, but when we test them under 35 pounds per square inch water pressure, they invariably leak. We are of the opinion that the trouble is due to the expansion of the iron and to the fact that the sealing compound in the joints is burned out. We shall appreciate your advice on how to secure a water tight coil in the casting.

Answer: We know of only one way in which a water-tight coil may be secured in a casting and that is to form the coil from one continuous length of pipe. Two or even three ordinary sections of pipe may be joined either by welding or by the ordinary union to form this continuous length. The only limiting factor in this arrangement is that the joints must come at a point as far as possible removed from the ends of the casting. In the event that openings *must* be provided in the ends of the coil we fear you will have to change the design of the casting so that the pipe connections may appear outside the ends. We have seen many castings in which cooling coils have been incorporated, but we never have seen one in which the coils had to be cleaned. Invariably the casting has been scrapped from some other cause before that time arrived.

Your conjecture that the law of expansion and contraction is responsible for the leaky condition of the pipes is correct. In addition to the tremendous strain set up in the approximately 60 feet of pipe forming the coil, during the time it is heating while the mold is filling with iron, another strain is set up while the metal is cooling on account of the difference in contraction between wrought iron, malleable iron and gray iron. The net result of the combined strains is that the pipes work loose in the connections.

Gives Committee Report on Steel Castings

During the recent convention of the American Foundrymen's association held at Philadelphia, May 14 to 18, a report was presented by the committee on steel castings. This report was presented at the session on steel founding which was held Wednesday morning, May 16. The committee report was presented by A. H. Jameson, Deemer Steel Casting Co., New Castle, Del., who is chairman of the committee. The other members are R. A. Bull, J. H. Hall and Lloyd Uhler. The report follows:

Last June, your committee appealed to you for support in a controversy regarding certain points in a specification proposed by a committee of the American Society for Testing Materials for steel valves and fittings for high temperature service. You responded in gratifying numbers and we are glad to report that at the general meeting of the American Society for Testing Materials in French Lick last June the objectionable changes were withdrawn and the specifications left as they had been, and as we wished them to be; the points at issue being referred back to the proper committee for further consideration and recommendations.

Since then, while a special committee was being formed to consider these controversial points, an attempt was made, informally, to reach a basis of compromise, but owing to the development of certain opposition the attempt did not then succeed. So at meetings of the American Society for Testing Materials committees held in March of this year, it was voted to refer these points back to the proper committees for further consideration, and the matter stands just where it did a year ago. We hope that a final settlement may be reached this coming year, one that will be acceptable to both sides.

To us, your committee, the most gratifying features of the entire matter have been the evidences of interest you have shown and the enthusiastic support you have accorded us."

Gives Refractory Data

The Crescent Refractories Co., Curwensville, Pa., recently has published a pocket-size, loose-leaf folder containing charts, formulas and rules for the use of those interested in refractory linings. It contains 20 bulletins which have been published at various times by the firm which include temperature conversion tables, temperatures and melting points, number of brick required for various circles, preparation and use of fireclay mortars, chimney design, and other useful data.

Data on the physical properties of low-carbon, chromium alloys of the stainless iron type are contained in scientific paper No. 570 recently published by the bureau of standards. This paper gives results on the linear thermal expansion of nine samples containing chromium from 11.9 to 16.4 per cent and carbon from 0.09 to 0.13 per cent.

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Reviews Aluminum Foundry Practice

Twenty-five Years of Aluminum Foundry Practice, by Charles Koehler. *Bulletin*, Association Technique de Fonderie de Paris, February, 1928.

Following a brief historical review of aluminum foundry practice since its origin, and a description of the present-day uses of the metal, reference is made to the recent successful use of alunite (sulphate of potassium and aluminum) by the Detroit Aero Metals Co. The importance of this discovery on the French industry, which is based mainly on using bauxite as a raw material, is emphasized.

The author then reviews the various alloys of aluminum that have become commercial in foundry practice, and gives a list of the principal compositions used in France, Great Britain, America and Germany. Reference is made to the fact that castings of the same composition and cast under practically identical conditions do not always give the same results in physical tests according to the part from which the test piece has been taken, and it is concluded that it is not necessarily true that the strength of the casting increases with the increase of the section. Other aluminum alloys which are used for forgings and can be reheated also are referred to, particularly the alloy manufactured by Schneider & Co., and duralumin. Reference also is made to a new alloy manufactured by Etablissements Metallurgiques de la Gironde and which has satisfactory mechanical properties. A section of the article is devoted to alpax. Reference is made to the future possibilities of the addition of glucinium to aluminum alloys. An addition of 5 per cent of this metal results in substantially better qualities for the alloy, but for the time being the price of this metal is stated to be $5000 a pound, and although it is expected that it soon will be reduced to $200 a pound, it still is a considerable factor in cost of production of aluminum alloys containing this rare metal.

A review of the furnaces used for melting aluminum is presented, and a brief description is given of a comparatively new furnace, fired by means of a coke gas producer, which has given good results. In the section dealing with melting practice, emphasis is laid on the losses during melting. Discussing the influence of impurities, the author lays stress on the precautions that should be taken that there should not be more than 2 per cent iron, as beyond that percentage iron is detrimental. The importance of gas inclusions also is emphasized. In connection with this point, the difficulty of embedding oil tubes in aluminum castings is referred to.

It is stated that molding practice in the case of aluminum is similar to that of the iron foundry. Aluminum foundry practice has served as a considerable incentive to the use of molding machines, and also die-casting is extensively used. The precautions to be taken on account of the considerable contraction of aluminum are given, and reference is made to the welding of aluminum. The article ends with a special reference to die-casting, which is extensively practised in France, and it also is stated that pressure die-casting, which is widely used in America, is also being developed in France.

Heat and Acid Resisting Iron

Notes on Heat and Acid Resisting Pig-Irons, by Tudis, *Foundry Trade Journal*, London, Feb. 2, 1928.

These notes were compiled from practical results by a foundry foreman. Iron with a white fracture gives the maximum heat resistance and should be made from metal low in total carbon, silicon and phosphorus. High sulphur iron is detrimental. Castings should be designed to eliminate sharp corners and too abrupt changes in section. Castings which must be machined should be on the gray side and have a close grain. An iron which gave good results had the following analysis: Total carbon, 3.06; silicon, 1.00; manganese, 0.48; sulphur, 0.064 and phosphorus, 0.19 per cent. For thin castings the silicon may be raised to 1.3 per cent. The manganese should be around 0.8 to 1.0 per cent. The mixture used contained 4½ cwts. West Coast hematite pig (silicon, 1.5); 4¼ cwts. South Staffordshire refined iron (silicon, 1.0 per cent); 1 cwt. return scrap; ¼ cwt. steel scrap not less than ½-inch thick. Molds should be heated to 300 degrees Cent.; gates and runners should be double the ordinary size; no great heads and no feeding are required; swish runners should be used where possible; metal must be run hot and a ladle for mixing is necessary.

French Foundrymen Progress

A new Era of Development of Gray Cast Iron, by C. Derulle, *La Revue de Fonderie Moderne*, Paris, Feb. 25, 1928.

Commenting upon an article by E. A. Custer on the same subject, M. Derulle says that owing to its indifferent tensile strength, lack of elongation and fragility, the qualities of gray cast iron must be improved so that it will not be superseded by cast steel and malleable iron. It is noted that good progress already has been made, due to the more scientific methods used today. The utilization of pulverized fuel is a great improvement which is developing in France, where certain grades of coal are extracted which can only be used in a pulverized state. The application has been made to heating furnaces and to cupolas.

The author considers the use of synthetic sand as a palliative. He believes in developing the sand preparing plant, especially in France where it would be difficult and costly to make a synthetic sand with qualities equivalent to the natural sands found in the country. He believes it is more economical in French foundries, and apart from exceptional cases, to make numbers of sand molds on the molding machine than to use permanent molds.

Discuss Rationalization

The Rational Organization of Work, by E. V. Ronceray and A. Dormoy, *Bulletin de l'Association Technique de Fonderie*, Paris, Jan. 1928.

This is the text of two papers read before the French foundry association. The same subject will be further treated at following meetings. In his lecture, Mr. Ronceray gives a general exposition of the principles of rationalization of work, and urges those who hold responsible positions in the industry, in industrial bodies and in the administration, to study these principles and enforce them in their works. The lecturer states that objections according to which rationalization results in unemployment and fatigue, are without foundation, and that the reverse is true. He lays stress on the difference that exists between rationalization and mechanization, or mass production, and shows that in certain cases better results can be obtained, for example, by well organized hand molding than by the application of machinery. Examples of the results obtained by rationalization of work done by hand are given. Mr. Ronceray emphasizes the importance of a production cost system, and the necessity of devising a standard system which should be adopted by all foundries.

M. Dormoy, foundry proprietor, is the author of a book on industrial production costs. In his address he deals more particularly with that subject, as being a part of the rationalization scheme. He suggests that in a foundry the costs should be divided between five departments: 1—making of the mold; 2—melting of the metal and casting of the mold; 3—fettling; 4—cost of raw materials; commissions, transportations, taxes, etc.; 5—overhead expenses, including financial charges, publicity, etc. Such a scheme should be adapted so that it could be applied even to small foundries. The author also refers to the necessity of standardizing products, and gives examples of results obtained in the United States.

In the discussion, M. Androuin, of the National Committee of Normalization, refutes four erroneous ideas often met with regarding organization in the works: 1—that rationalization applies only to mass production work; 2—that it can only be applied in large organizations; 3—that it exerts a bad influence on the workers; 4—that unskilled workers are not apt to understand the principles and objects of rationalization.

The Shakeout

DAN M. AVEY, Editor

PAT DWYER, Engineering Editor
FRANK G. STEINEBACH, Associate Editor

CHARLES VICKERS, Nonferrous Editor
EDWIN BREMER, Associate Editor

¶ Machinery Makes Prosperity

SPEAKING before the recent meeting of the National Industrial Conference board in New York, Magnus W. Alexander, president of that body, declared that our national prosperity may be attributed largely to the remarkable progress that has been made in the mechanization of industry in the United States. He stated that the application of machinery to the problems of industry not only has improved greatly the working conditions of the men in industry, but also has resulted in radical changes in the entire social structure of the country by raising the standards of living far above the fondest dreams of our forefathers. An increased earning power is found among workers in industries where machinery is used extensively, and this has provided a large percentage of the population with a means of enjoying the better things of life, of acquiring more education, of devoting more time to social activities and of widening the social sphere.

AT THE same time Mr. Alexander sounded a note of warning which should be heeded by every man who has a part in guiding the destinies of industry. Confusion of thought and ignorance of facts have resulted in the revival of an old economic fallacy, which in its present status may be unimportant, but if allowed to gain momentum, may become a disastrous influence. In certain quarters, men, who a few years ago hailed the adoption of machinery as the keystone of the nation's prosperity, now raise the cry that the use of machinery is the cause of unemployment. Over a period of 150 years, history has demonstrated time and again the fallacy of this argument to the complete satisfaction of the majority, but it still continues to hold the minds of men.

AS AN example of what may be accomplished through the increased use of machinery, Mr. Alexander cited the changes which have been made in the automobile industry. Increased efficiency resulting from an increase in the use of machinery made it possible for 71 men to produce the same volume in 1925 as that produced by 100 men in 1904. A question naturally arises regarding the 29 per cent of workers seemingly thrown out of work. The answer is found in the increased demand resulting from a lower manufacturing cost and therefore a lower selling price. Greater demands on the part of the public has been sufficient to create employment, not only for the 29 per cent of workers theoretically released, but for 1,500,000 additional wage earners.

¶ Specifications Needed

FOR many years, coke has been one of the variables encountered in melting iron in the cupola, due largely to slight variations in the analysis of coke marketed by the various producers. When foundrymen have found it necessary to change the source of their coke supply, a certain amount of experimental work usually has been found essential to determine the proper coke ratios and the effect of the coke on the analysis of the iron melted. On the other hand, coke producers have found it rather difficult and more or less expensive to meet the individual specifications demanded by foundrymen.

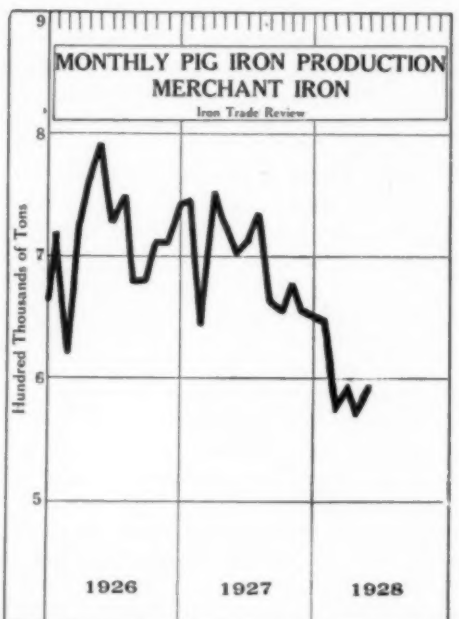
STEPS toward standard specifications for coke have been considered by the American Society for Testing Materials, and at the recent Philadelphia convention of the American Foundrymen's association, a technical session, presided over by Arthur J. Tuscany, secretary, the Ohio State Foundrymen's association, was devoted to a discussion of the advisability of preparing standard specifications for foundry coke. At that meeting, W. L. Selvig, bureau of mines, Washington, told of the increased demand for such a set of specifications. In the round table discussion, James T. MacKenzie, chairman of the A. S. T. M. subcommittee of coke, gave a general idea of what he considers should be included in coke specifications. While a number of those taking part in the discussion agreed upon the desirability of specifications governing foundry coke, many expressed the belief that many foundrymen do not seem to know exactly what is desirable in that type of fuel. Evidently considerable study and educational work will be required to arrive at specifications agreeable to all.

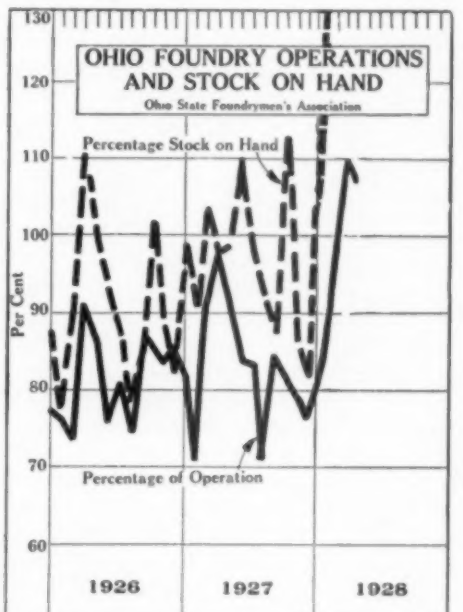
Trade Trends in Tabloid

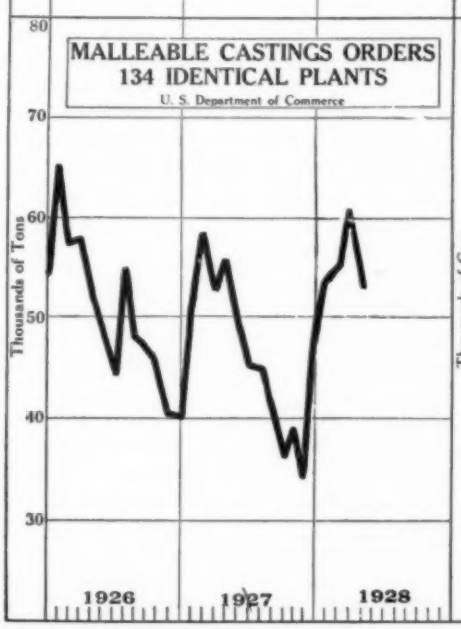
FOUNDRYMEN in general are expressing greater satisfaction with the state of their business than they did earlier in the year. The volume of jobbing orders has increased, while specialty manufacturers have been favored due to the continued high rate of buying. Automotive and agricultural implement manufacturers have provided a steadily increasing castings demand. Stove and furnace work is satisfactory for the present period of the year. Shipments of pig iron reflect an optimistic undercurrent in the foundry industry. Only the railway lines have failed to give any assurance of better future for castings makers. Steel castings demand still lags, due in large measure to the reluctance in placing new car orders. The total freight car awards for May again registered a drop. The total of pig iron production as reported by *Iron Trade Review* increased from 3,181,975 tons in April to 3,284,811 tons in May, but the daily average made in May was 105,962 tons compared with 106,066 tons in the preceding month. Merchant iron totaled 586,045 tons in April and 595,225 tons in May. Average nonferrous prices during May, according to New York quotations in *Daily Metal Trade*, follow: Casting copper, 14.136c; electrolytic copper, 14.440c; Straits tin, 51.577c; lead, 6.126c; aluminum, 23.90c; antimony, 10.906c. Zinc averaged 6.032c, E. St. Louis, Ill.

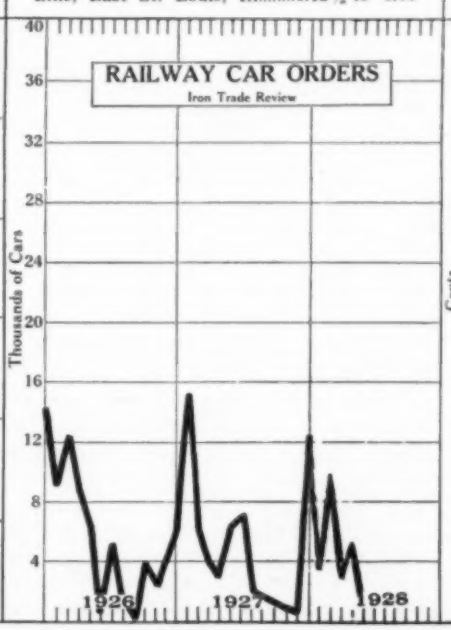
RAW MATERIAL PRICES
June 7, 1928

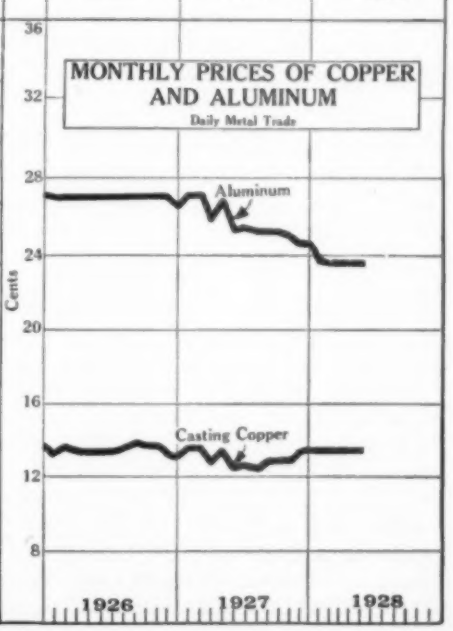
Iron	
No. 2 foundry, Valley	$17.00
No. 2 southern, Birmingham	16.00
No. 2 foundry, Chicago	18.00
No. 2 foundry, Philadelphia	20.76
No. 2 foundry, Buffalo	17.00
Basic, Valley	15.35 to 16.00
Basic, Buffalo	17.00
Malleable, Chicago	18.00
Malleable, Buffalo	17.50
Coke	
Connellsville foundry coke	$3.50 to 4.25
Wise county foundry coke	5.00 to 5.25
Scrap	
Heavy melting steel, Valley	$14.25 to 14.75
Heavy melting steel, Pitts	14.50 to 15.00
Heavy melting steel, Chicago	12.75 to 13.25
Stove plate, Buffalo	13.00 to 13.25
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.25 to 14.75
No. 1 cast, Philadelphia	16.00 to 16.50
No. 1 cast, Pittsburgh	14.00 to 14.50
No. 1 cast, Birmingham	14.00 to 14.50
Car wheels, iron, Pittsburgh	14.50 to 15.00
Car wheels, iron, Chicago	13.25 to 13.75
Railroad malleable, Chicago	13.00 to 13.50
Agricultural Mal., Chicago	11.75 to 12.25
Malleable, Buffalo	15.00 to 15.50
Railroad malleable, Pitts	15.00 to 15.50
Nonferrous Metals	Cents per pound
Casting copper, refinery	14.50
Electro copper, producers	14.62½
Straits tin	49.25
Lead, New York	6.30
Antimony, New York	10.50
Nickel, electro	37.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	16.50 to 17.00
Zinc, East St. Louis, Ill.	6.12½ to 6.15











Personal

W. C. Katker, formerly vice president and assistant general manager, Favorite Stove & Range Co., Piqua, O., has been elected president of that company.

R. F. Johnson, formerly sales manager of the Alemite Die Castings & Mfg. Co., Chicago, recently was appointed sales manager of the Newton Die Castings Co., New Haven, Conn.

Howard E. Handy, metallurgist, the Saco-Lowell Shops, Lowell, Mass., has changed his headquarters from Lowell to Biddeford, Me., where the metallurgical laboratory of the company will be located.

Samuel F. Dixon, vice president, Barlow Foundry, Inc., Newark, N. J., recently spoke before the Newark Foundrymen's association.

Fritz Meyer, American Radiator Co., Springfield, Ill., spoke before the Wisconsin Gray Iron Research group at a meeting held in the Republican house, Milwaukee, Wednesday evening, June 6, on the subject of "The Pulverized Fuel Cupola."

J. D. Miller, Cresson-Morris Co., Philadelphia, addressed the Newark Foundrymen's association Wednesday evening, June 6 on the subject "Some Recent Developments in Cupola Metal."

W. M. Corse, consulting metallurgist, Washington, and secretary of the Institute of Metals division of the American Institute of Mining and Metallurgical Engineers, attended the meetings of the Institute of Metals of Great Britain in London the week of May 8. Mr. Corse visited France, England, Sweden and Norway and addressed the Society of Scientific and Industrial Research, Stockholm, Sweden, on the subject of "Industrial Research in the United States."

Detroit Foundrymen Meet

The annual banquet of the Detroit Foundrymen's association was held at the Fort Shelby hotel, Detroit, Thursday evening, May 24. Several talks were made, with James W. Dopp acting as toastmaster. George M. Read, judge probate court, spoke on "Molding Character"; Fred Erb, Erb-Joyce Foundry Co., talked on the Gray Iron institute; S. Wells Utley, Detroit Steel Casting Co., spoke on the work of the recent Philadelphia convention and David R. Wilson, Wilson Foundry & Machine Co., Pontiac, Mich., related some happenings in the automobile industry. Special entertainment was provided and a mock trial also was held with the following foundrymen taking part: Judge, Jesse D. Stoddard, Detroit Testing Laboratory; police officer, James Mahon, American Car & Foundry Co.; prosecuting attorney, Morris Miller; complaining witness, Vaughn Reid, City Pattern Works; attorney for the defense, Steward Nichols, assistant prosecuting attorney Wayne county; clerk of court, Fred J. Walls, Wilson Foundry & Machine Co.; culprit, Henry M. Lane; one man jury, John D. Cronenweth, Great Lakes Sand Co.

Made District Manager

J. R. Allison recently was made district manager of the C. O. Bartlett & Snow Co., Cleveland. Following graduation from the University of Pittsburgh, Pittsburgh, Mr. Allison was made field engineer for the Edgewater Steel Co., and later served for a number of years in the mechanical department of the Pennsylvania railroad. Since the war he has been connected with the Carnegie Steel Co., in the construction department at the Homestead Works.

Describes Foundry Work

The Pittsburgh Foundrymen's association recently published an interesting and attractive booklet entitled "The Call of The Foundry." This booklet contains information upon the part played by the foundry industry in the production of manufactured products in Pittsburgh, and was published with the idea of interesting boys in the foundry apprenticeship courses offered in the district. The booklet also contains information on the course in foundry practice conducted by the Pittsburgh public schools, as well as information on the qualifications necessary for this training work. The publication is well illustrated with reproductions of photographs including many of interiors of foundries.

Made of Cast Iron

In a description of a new cupola recently introduced by the Whiting Corporation which appeared in the May 15 issue, it was stated that the bottom doors are fabricated from heavy boiler plate. This statement is in error since the bottom doors are of cast iron. However, the bottom plate of the cupola is fabricated from heavy boiler plates and structural shapes.

Offices of A. A. Wickland & Co., Inc., consulting engineers, have been moved to the Engineering building, 205 West Wacker Drive, Chicago.

Book Review

Foundry Work; by R. E. Wendt, head instructor in foundry practice, Purdue university, Lafayette, Ind.; cloth; 236 pages, 4½ x 7½ inches; published by McGraw-Hill Book Co., and furnished by THE FOUNDRY for $2.00.

This is the second edition of a work which the author has used for several years in teaching the elements of foundry practice to the engineering students in a Middle West university. The subject matter has been somewhat revised in this second edition and many new illustrations have been included. In preparing this book the author's aim has been to provide a suitable text for students in schools and colleges and for apprentices in foundries. It is elementary to the extent that the fundamental principles are presented briefly, but still in sufficient degree to give the student a general working knowledge of foundry practice.

The work is presented in four parts. The first part takes up some fundamental principles, varieties of castings, foundry layout, preparation of molding sand, facings, gating and feeding iron castings, use of gaggers, chaplets and molder's tools. In the second part a number of exercises are presented in bench and floor molding methods, two and three-part molds, pit molds, sweeps, open sand, match plates, follow boards and gating patterns; different types of molding machines; mold fillers, and sifters, core sand mixers. Principles of core making are explained and exercises are provided.

Melting furnaces for gray iron, brass and aluminum are illustrated and explained in the third part. This part also deals with the melting of metal, mixing and making up the charges. Methods and equipment for cleaning castings are described and illustrated. The fourth part deals with laying out a typical foundry, how the cupola is lined, charged and operated. How to compute mixtures from chemical analyses. Other features include charging sheets, melting losses and melting ratios, testing cast iron, calculating the cost, estimating the weight from drawings, weight for holding copes, designing flasks and a comparison of different methods of making the molds.

J. H. Phinney has been appointed representative for the eastern part of Michigan with headquarters at Detroit by the Magnetic Mfg. Co., Milwaukee, manufacturer of magnetic separators and magnetic clutches. Mr. Phinney's office will be located at 420 U. S. Mortgage building, Detroit.

Obituary

James S. Llewellyn, aged 40, vice president, Chicago Malleable Castings Co., West Pullman, Ill., died May 27 at his home in Chicago, following a short illness of pneumonia. Mr. Llewellyn was a graduate of the University of Michigan, Ann Arbor, Mich., and became secretary of the Chicago Malleable Castings Co., in 1907. He was made vice president in 1925.

Ira H. Spencer, president of the Spencer Turbine Co., Hartford, Conn., died recently. Mr. Spencer began his experiments with water motors and air compressors early in life and at the age of 18 developed a water motor which still is used to pump the organ in a Hartford church. In 1895 he organized the Spencer Motor Co., which was sold to the L. E. Rhodes Co., and later became the Organ Power Co. In 1904 Mr. Spencer began experiments with stationary exhauster for cleaning buildings by the vacuum method and three years later organized the Spencer Turbine Cleaner Co. The Spencer Turbine Cleaner Co., and the Organ Power Co., were consolidated in 1918 as the Spencer Turbine Co., with Mr. Spencer as president.

Sanford B. Belden, vice president, the Jeffrey Mfg. Co., Columbus, O., died May 15 at the hotel Chatham, New York. Mr. Belden joined the Jeffrey organization in 1896, shortly after graduating from the school of mines, Ohio State university, Columbus. After serving in the sales department, he was made manager of the Pittsburgh office, where he remained 12 years. In 1909 he was made vice president and manager of the mining division and in 1926 was elected vice president and director of the Jeffrey Mfg. Co., and in addition was made chairman of the board of British Jeffrey-Diamond Ltd., Wakefield, England.

Samuel J. Taylor, president of the Pinkston Sand Co., Michigan City, Ind., died at his home on May 26, at the age of 61. Mr. Taylor was born in Scotland in 1867 and came to the United States in 1888. He worked for several years in Chicago and then went to Michigan City where he was connected with several industrial concerns, including the Haskell & Barker Car Co., now a part of the Pullman Co. Mr. Taylor was active in civic problems and at one time was deputy chief of the Indiana bureau of statistics.

William Sackett, manager, United States Cast Iron Pipe & Foundry Co. plant, Addystone, O., died recently from injuries sustained when struck by an automobile. Mr. Sackett was 72 years old.

A. M. Campbell, chairman, Glamorgan Pipe & Foundry Co., Lynchburg, Va., died May 7 in Richmond, Va., following an operation. He had been connected with the firm for more than 30 years, and was well known in the industry.

Philip C. Smith, formerly superintendent of the foundry, Ingersoll-Rand Co., Easton Pa., died after an illness of three weeks at his home in College hill, Easton, at the age of 75 years. Mr. Smith was born in Manchester, N. H., and served his time in the foundry of the Amoskeag Mfg. Co., Manchester, and later worked in various shops on the Pacific coast. He was one of the organizers of the Troy Engine & Machine Works, Troy, Pa., and then became foundry superintendent in charge of all foundries of the Camden Iron Works, Camden N. J., where he remained for seven years. Mr. Smith then became associated with the Radford Pipe & Foundry Co., Radford, Va., as general superintendent. In 1898 he went to Easton, Pa., to become foundry superintendent for the Ingersoll-Rand Co. which position he occupied for 22 years. He retired from this position in 1920 and formed the Vulcan Facing Co., Easton, Pa. Mr. Smith contributed articles on foundry practice to the technical press, and was a member of the American Society of Mechanical Engineers.

Faked Foundry Facts

Hot Sand

Book Review

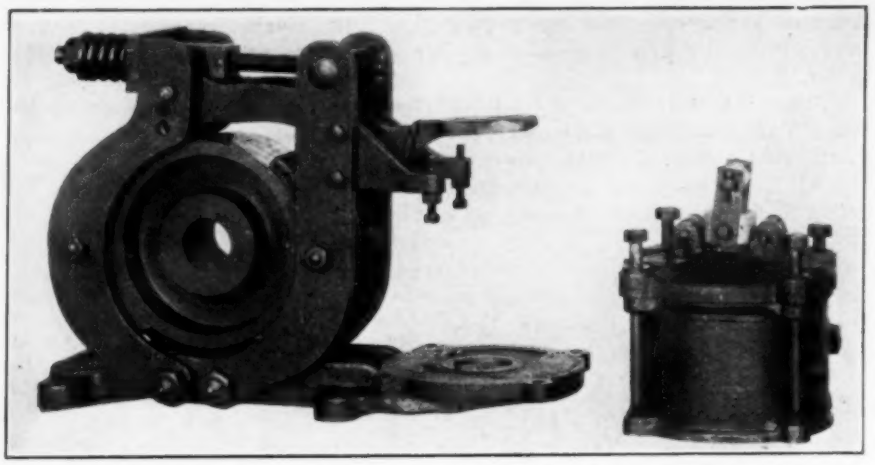
Abrasive Handbook, by Fred B. Jacobs, cloth 560 pages, 6 x 9 inches, published by the Penton Publishing Co., Cleveland, and furnished by the Foundry for $5 and in Europe by the Penton Publishing Co. Ltd., Caxton House, London, for 25s.

The entire abrasive industry represents a slow development of some 30 years followed by more rapid progress during the past 20 years. With the steady advancement of the industry, rule-of-thumb methods gradually were replaced by scientific practices so that today the industry is a recognized branch of modern engineering. While much has been written in time past pertaining to abrasives and abrasive machinery, the industry has been without a handbook. To be sure engineering handbooks furnish a few scant pages whereing certain fundamental principles are given, but when the abrasive engineer, superintendent, grinding room foreman, or grinding room machine operator desires information on specific subjects he is confronted with the problem of making an extensive research through endless back files of technical magazines and often without satisfactory results.

The handbook is divided into 14 sections, classified as follows: Abrasive materials, abrasive paper and cloth, abrasive producers, cylindrical grinding, diamond data, disk grinding, grinding machines, grinding practice, grinding wheels, honing practice, miscellaneous abrasive data, miscellaneous abrasive operations, polishing and buffing, and the safe operation of wheels.

The book is illustrated throughout, and the type is comparatively large for a work of this kind, thus making it much easier to read than the ordinary handbook. As a reference work for works managers, chief engineers, designers, abrasive engineers, grinding room foremen and grinding machine operators, this book will fill a long-felt want.

Carl O. Thieme has become associated with the H. Kramer & Co., Chicago, as metallurgist. For the past ten years Mr. Kramer has been connected with the Michigan Smelting & Refining Co., Detroit, in various technical capacities.



SOLENOID BRAKE FOR OPERATION ON ALTERNATING OR DIRECT CURRENT

Builds Solenoid Brakes

The General Electric Co., Schenectady, N. Y., recently has introduced a new line of solenoid brakes for operation on alternating and direct current. The brakes are designed especially for severe service in crane or hoist motors. The manufacturer claims smooth operation for making quick stops in either direction of rotation, with a special holding device. The brake mechanism is held in the off position by a coil plunger. When power is applied to the motor, the coil is energized and the brake is released. When the power is shut off, the spring setting device forces the mechanism into the closed or braking position.

Both alternating and direct current brakes use the same brake mechanism and frame, the solenoids being interchangeable. Exceptionally small diameter brake wheels are used, to minimize flywheel effect. A wide wheel face gives ample braking surface. The solenoid assembly may be removed quickly from the brake mechanism by taking out four bolts, the lever or brake adjustment remaining undisturbed.

Sandblast Barrel Has an Apron Conveyor

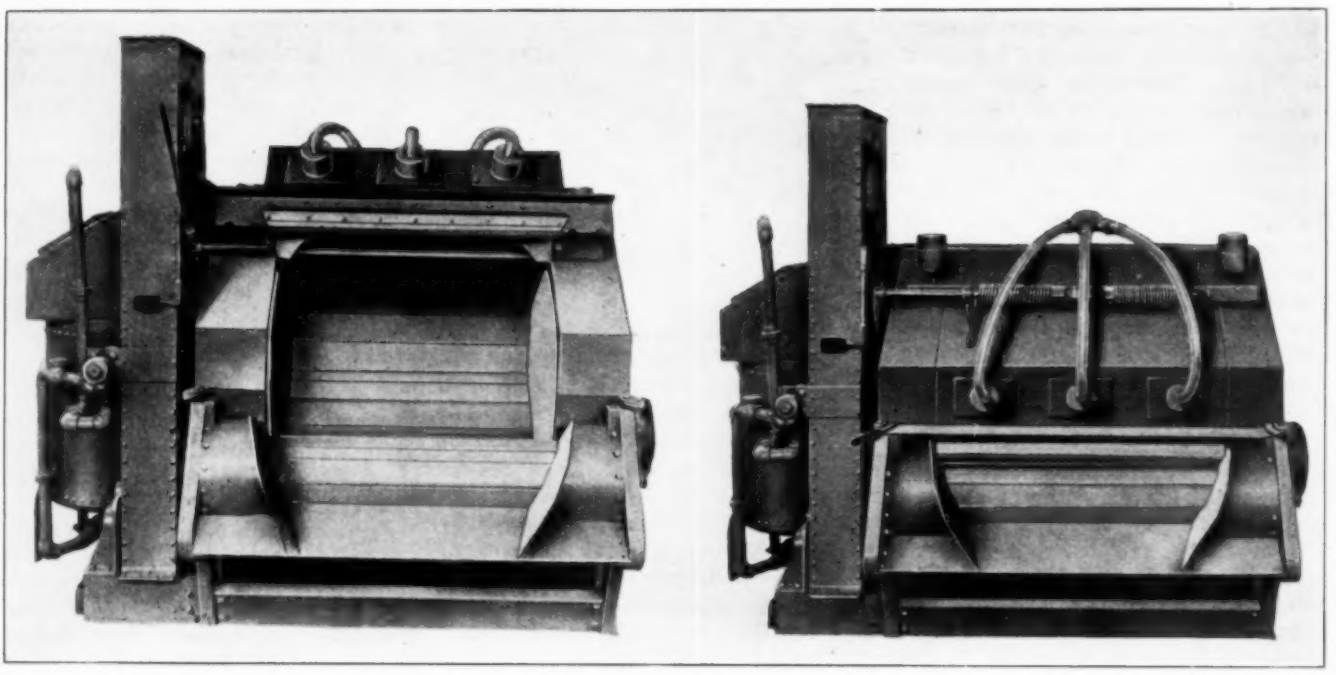
A new application of the sandblasting, tumbling principle of cleaning castings recently has been developed by the American Foundry Equipment Co., Mishawaka, Ind. This device consists of an encased apron conveyor which travels from front to back. Two thousand pounds or more of castings may be cascaded continuously into position in front of the blast nozzle for cleaning. When the cleaning operation has been completed the direction of the conveyor travel is reversed and the load is fed upon an unloading belt or other convenient receptacles.

Three ⅜-inch nozzles are used. The nozzles are located in the door, are aimed directly at the work and have a positive adjustment which it is claimed cannot get out of alignment. The door is counterbalanced by a heavy coil spring which may be adjusted readily to the desired tension. The door opens the full length of the barrel and for a width of approximately 42 inches.

Dust is drawn directly from the interior of the barrel as fast as it is produced, and the used abrasive is given a double air scrubbing before it is returned to the system. This barrel is 42 inches long and has an inside diameter of 36 inches. The end frames are one piece gray iron castings and the cylinder sockets are of gray iron. Views of the barrel with the door open and also with the door in place are shown in the accompanying illustration.

Machine Blows Sand Into the Mold

A new type molding machine designed to fill the flask with sand driven by air pressure was shown in operation at the exhibition recently held in Philadelphia. It is the invention of O. Nagel, managing director Badische Machine Works, Durlach, Germany, claimed to be the largest manufacturer of foundry equipment in



THE DOOR IS COUNTERBALANCED WITH A HEAVY COIL SPRING. THREE NOZZLES IN THE DOOR DIRECT THE BLASTING STREAM AGAINST THE CASTINGS

Europe. Mr. Nagel accompanied the machine to this country and was present at the exhibition every day to supervise and explain its operation. Albert T. Otto & Sons, represent the owners in the United States and Canada.

The first machine manufactured was shown at the Paris foundry convention September 1927 and since that time it is stated many of the machines have been installed in various European countries. This new molding machine was described briefly on page 147 in the Feb. 15 issue of THE FOUNDRY.

The machine blows sand in a continuous stream into a flask to effect a uniform compression. Degree of compression under which the sand is delivered may be varied considerably by adjusting the ratio between the sand and the air. The adjustment readily is effected by the operator holding the nozzle. This nozzle also may be directed either vertically or at any angle desired, thus permitting ramming to a uniform density.

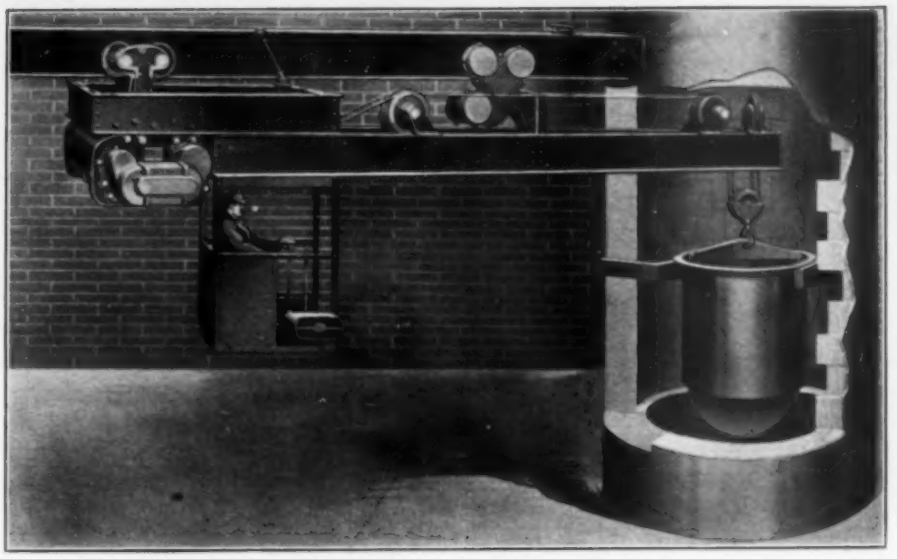
The machine shown in the accompanying illustration consists of a cylindrical cast iron container equipped with a revolving plate near the bottom driven by a motor and having suitable means for feeding the sand uniformly to the orifice of a flexible hose through which the sand is carried in a continuous stream to a nozzle by compressed air. The container has a capacity of 3 cubic yards and is supplied with additional sand from a hopper above. The hopper may be filled in many ways depending on local conditions. The machine on display was fed by a sand throwing machine made by the Axmann Sand-Throwing Machine Co., Cleveland.

In foundries with mechanical sand handling systems the hopper may be filled from a belt, a reciprocating conveyor, a storage bin, etc.

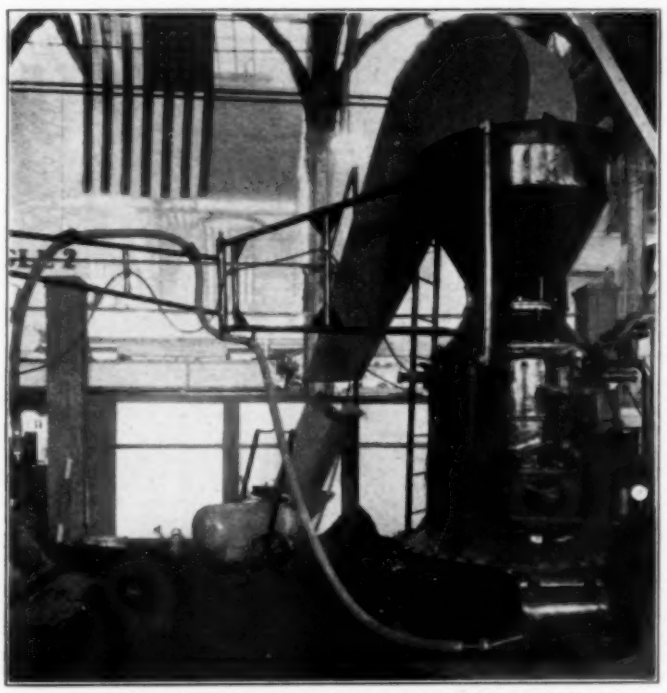
Capacity of the machine may be varied from 4 to 12 cubic feet of sand per minute delivered to the flask. This requires from 175 to 280 cubic feet of air at a pressure varying from 21 to 35 pounds per square inch. The power consumption is given as 4 to 5 kilowatts per hour.

The boom supporting the hose may be from 16 to 50 feet in length with a swing through 250 degrees. The hose length varies from 26 to 70 feet, thus enabling the operator to work over an area of 4800 square feet of floor surface. It is claimed that the sand does not wear the inside surface of the hose to any appreciable extent. Sand in the container is held under air pressure. On the top it is separated from the supply hopper by a valve. The container is equipped with a revolving distributing plate which feeds the sand to a small chamber where it is met by a stream of compressed air and thus forced through the hose to the distributing nozzle.

The machine is built in two types. One is designed to remain in one location on the floor and serve all the molds in the vicinity. The second is mounted on a carriage and may be moved to any desired location on a suitable track laid on the floor.



A FLANGE ON THE BUCKET RESTS ON A SPECIAL SUPPORTING CASTING IN THE CUPOLA AND ALLOWS THE BUCKET BOTTOM TO DROP



THE MACHINE IS BUILT IN EITHER THE PORTABLE OR STATIONARY TYPES

Charging Equipment Has Special Dump Bucket

The Whiting Corp., Harvey, Ill., recently has developed a new system for charging cupolas mechanically. This system is based on the use of special dump buckets holding the coke and iron. The dump bucket which may be either of the cone or hinge bottom types, is provided with an extended flange around the top, so that when the bucket is lowered into the cupola, this flange engages a supporting casting and allows the bottom to drop. The supporting casting is made of heat resisting material and it is claimed that under normal conditions will last indefinitely. When necessary it may be replaced easily. This bucket support rests on the cupola at three different points and resembles somewhat the shape of a wishbone.

As soon as the charge is dropped and the bucket is hoisted again, the bottom closes automatically and remains closed. It then may be carried to the yard for reloading.

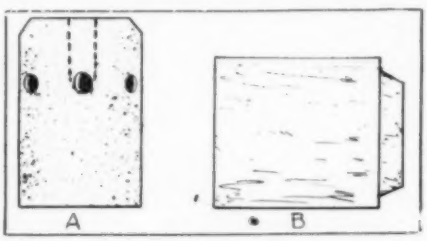
The accompanying illustration shows the new monorail type of charger as well as the charging bucket. The monorail charger is an adaptation of the hoist manufactured by the American Engineering Co., Philadelphia. The new charging system also may be applied to an overhead crane.

Strainer Core Insures Clean Castings

By J. R. Anderson

A recent issue of THE FOUNDRY contained an illustration and short description of a strainer gate core claimed to have been in use for over three years. About 26 or 27 years ago I designed a runner core along somewhat similar lines, but not quite so elaborate, and THE FOUNDRY of that day contained a description of it. Since that time I have employed it on thousands of steam cylinders and hundreds of hydraulic rams and heads. If the runner and core are intact after the casting is shaken out I send the casting into the machine shop with full confidence that it will clean up perfectly. I think the runner described by M. R. Burns in a recent issue of THE FOUNDRY is well adapted to the purpose for which it was designed, but its use involves more trouble than mine. In over 50 years experience in the foundry I have used all kinds of gates, but never have found one equal to that shown in the accompanying illustration.

B is an ordinary 6-inch bushing pattern with a 5-inch diameter tapered point at one end. This bushing is rammed up in the runner box directly over the gate opening in the cope. *A* is a 5-inch diameter dry sand core with a print at one end to fit in the print in the runner box after the bushing pattern is removed. The core has a 2-inch hole in the center



A IS A PERFORATED CORE WHICH FITS IN THE RUNNER BASIN MADE BY THE BUSHING PATTERN *B*

and eight ½-inch diameter holes spaced equidistantly and leading from the outside to the 2-inch hole in the center. These small holes are located slightly above the line of the core print. In practice the iron fills the runner basin with all slush and foreign material floating on the top while the clean iron passes through the eight ½-inch openings down near the bottom and thence into the down runner in the cope leading to the mold.

Sells Sand Separators

Sand separators and blenders manufactured by the Royer Foundry & Machine Co., Kingston, Pa., have been sold to the American Casting Co., Birmingham, Ala.; Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.; Consolidated Machine Tool Corp. of America, Hilles & Jones Works, Wilmington, Del.; Ephrata Mfg. Co., Ephrata, Pa.; Hubbard Steel Foundry Co., East Chicago, Ind.; Landers, Frary & Clark, New Britain, Conn.; F. E. Myers & Bro. Co., Ashland, O.; National Foundry Co. of N. Y., Inc., Brooklyn, N. Y.; Otis-Fenson Elevator Co., Ltd., Hamilton, Ont.; Schneider Bowman Co., Inc., Philadelphia, and the Wright Aeronautical Corp., Paterson, N. J.

R. C. Bird has been made traveling sales manager of the D. O. James Mfg. Co., Chicago. Mr. Bird formerly was connected with the Chain Belt Co., Milwaukee.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

The foundry of Rogers Iron Works Co., Joplin, Mo., was burned in a recent fire.

Athens Stove Works, Athens, Tenn., plans to build a 1-story addition to its molding room.

Century Electric Co., St. Louis, E. S. Pillsbury, president, plans to build a foundry.

North Attleboro Foundry, Attleboro, Mass., has been purchased by Gerald E. Croke of Attleboro, who will operate it.

The Fort Pitt foundry of the Mackintosh-Hemphill Co., Pittsburgh has been sold to the Pennsylvania railroad for $1,275,000.

Pratt & Letchworth Co., 189 Tonawanda street, Buffalo, manufacturer of steel castings, plans an expansion program.

J. B. Harbison, president of a local committee, is negotiating with a company to establish a stove foundry at Columbia, Tenn.

Walker & Meade has been formed by W. J. Walker and J. A. Meade to take over the business of the W. B. George Foundry Machinery Co., 3133 West Lake street, Chicago.

Barbour Stockwell Co., 205 Broadway, Cambridge, Mass., has awarded the general contract for a 1-story brass foundry to be built at Broadway and Market streets.

Gogan Machine & Foundry Co., 1440 East Fifty-fifth street, Cleveland, will change its name to the Gogan Machine Co., July 1. It will no longer operate a foundry.

Columbia Pattern & Mfg. Co., Cleveland, in addition to making wood and metal patterns, is now also manufacturing a tire rim spreader and a nickel steel wheel puller.

Central Pattern Works, 1186 East Seventy-first street, Cleveland, has begun the manufacture of plumbing and metal specialties. It is continuing its line of wood and metal patterns.

Southern Malleable Iron Co., Twenty-first and Bond streets, East St. Louis, Ill., has awarded the contract for a 1-story foundry addition, 85 x 280 feet, to the St. Louis Structural Steel Co.

Armitage Casting Co., 134 North La Salle street, Chicago, has been incorporated with $10,000 capital to manufacture and deal in brass, bronze and iron castings, by Ben J. Granat.

Crawford & McCremmon Co., Brazil, Ind., has been sold by David W. Wood, receiver, to Mayor Bros., Waukesha, Wis. The plant is being repaired and soon will be placed in operation.

F. A. Macbeth Co., Brazil, Ind., recently has received orders for a number of large cement works castings for shipment to several distant points in the United States and to Cuba and Uruguay.

K. & M. Brass & Aluminum Castings Co., Cleveland, has resumed operations after being idle a year. Officers of the company are: President, A. F. Misch; treasurer and secretary, E. J. Kortan; and general manager, R. F. Male.

B. B. Pattern Shop, 6411 Union avenue, Cleveland, is being conducted by William R. Butler, who has become sole owner since the death of the president, George E. Butler, last October. The line of wood and metal patterns is being continued.

A bronze shield recently was presented to the P. & O. Plow Works of the International Harvester Co., Canton, Ill., for good housekeeping. The shield was presented by E. E. Hagberg, superintendent of the plant and was accepted by Charles Slavin, foreman of the foundry.

Negotiations are under way for the merging of the Foos Engine Co. of Springfield, O., manufacturer of diesel engines, with the Fulton Iron Works, St. Louis, maker of sugar and other machinery. Plans and contracts for the consolidation are before the directorates of the two companies.

Falk Corp., Bucyrus-Erie Co., Harnischfeger Corp., Sivyer Steel Castings Co., Wehr Steel Co., George H. Smith Steel Casting Co., Milwaukee Steel Foundry Co. and National Brake & Electric Co., all of Milwaukee, and the Racine Steel Casting Co., Racine, Wis., which for several years have been associated for research work, have presented the College of Engineers of the University of Wisconsin, Madison, Wis., a fund of $15,000 to undertake a three-year program of research in metallurgy. The university has accepted the fund.

The Baldwin Locomotive Works will hold brief exercises June 28 to mark the complete removal of the company's manufacturing and administration departments from Philadelphia to Eddystone, Pa. An address will be made by James J. Davis, secretary of labor. A special train will carry members of the American Railway association from Atlantic City, where they will hold their annual convention, to Eddystone to attend the ceremonies. No steps, it is said, have been taken regarding the disposal of the Philadelphia property.